IJOFSA
INTERNATIONAL JOURNAL OF
SUSTAINABLE FOOD SYSTEMS AND AGRIBUSINESS

International Journal of
Sustainable Food System and Agribusiness
Volume xx : xx-xx, Month Year
E-ISSN: xxxx-xxxx | https://doi.org/xx/ijofsa.xx

Sensory and Hedonic Evaluation of Egg Noodles Incorporated with Beetroot (Beta vulgaris L.) Powder as a Functional Food

Naura Taqiyyah [1], Ni Putu Vida Indriani Putri[2]
Food Technology Study Program, Institut Teknologi dan Bisnis Muhammadiyah Bali, Jl. Bypass Ngurah Rai No.19, Sidakarya, Denpasar Selatan, Kota Denpasar, Bali, 80224 Indonesia
Corresponding author: taqynaura@gmail.com; Tel.: +6285158522741

A B S T R A C T

Egg noodles are widely consumed globally due to their affordability, ease of preparation, and high consumer acceptance. The incorporation of plant derived ingredients, such as beetroot (Beta vulgaris L.) powder, may enhance nutritional value and visual appeal due to the presence of natural pigments and bioactive compounds. However, changes in formulation can also influence sensory attributes, which are crucial for consumer preference. This study aimed to evaluate the sensory acceptance of egg noodles with the addition of beetroot powder using both similarity based scoring tests and preference-based hedonic tests. Two formulations were prepared: control noodles without beetroot powder and noodles with added beetroot powder. Sensory evaluation was conducted with 15 semi trained panelists, assessing texture and taste similarity via scoring tests and preference for aroma, color, texture, taste, and overall acceptance via hedonic tests. Data were analyzed using one-way analysis of variance at a 5 % significance level. The results showed no significant differences between control and beetroot powder noodles in both scoring and hedonic tests ($p > 0.05$). Noodles with beetroot powder exhibited slightly higher mean scores for color and overall acceptance, indicating a positive response to beetroot's natural pigmentation. These findings suggest that the addition of beetroot powder maintains sensory similarity and acceptance comparable to conventional egg noodles. In conclusion, beetroot powder can be introduced into egg noodle formulations without adversely affecting sensory quality, offering potential for product diversification with plant-based ingredients.

A R T I C L E I N F O

Article history:
Received: Month 1st, Year
Revised: Month 1st, Year
Accepted: Month 1st, Year
Published: Month 1st, Year

Keywords: beetroot powder; egg noodles; sensory evaluation; scoring test; hedonic test

1. INTRODUCTION

Noodles are among the most widely consumed staple foods worldwide due to their affordability, ease of preparation, and high consumer acceptability. Consumer acceptance of noodle products is strongly influenced by sensory attributes, particularly color, texture, aroma, and taste, which play a decisive role in product preference and market success (Chhikara et al., 2019; Kumar & Upadhyay, 2024). In addition to sensory quality, there is a growing interest in enhancing the nutritional value of noodles through the incorporation of bioactive compounds, positioning noodles not only as staple foods but also as potential functional food products.

In recent years, numerous studies have explored the use of alternative plant derived ingredients in noodle production to improve nutritional quality and product diversification. The incorporation of tubers, fruits, and vegetable based powders has been reported to modify both physicochemical and sensory properties of noodles (Pakhare et al., 2021; Chhikara et al., 2019).

While such innovations provide opportunities to develop functional noodle products, changes in formulation may alter sensory characteristics compared to conventional wheat based noodles, potentially affecting consumer acceptance.

Beetroot (Beta vulgaris L.) is a tuberous plant widely recognized for its high content of bioactive compounds, particularly betalain pigments and folate. Betalains, consisting of betacyanins and betaxanthins, are natural water soluble pigments responsible for the characteristic red-purple color of beetroot and are known for their antioxidant properties (Clifford et al., 2015; Delgado Vargas et al., 2000). In addition, beetroot is an important natural source of folate, a B-vitamin essential for DNA synthesis, cell division, and the prevention of neural tube defects, making it a promising ingredient for functional food development (Gujska et al., 2017; EFSA, 2014).

The incorporation of beetroot powder into noodle formulations is therefore expected to provide dual benefits: enhancement of nutritional value through natural folate content and improvement of visual appeal through betalain pigmentation. However, the addition of beetroot powder may also influence sensory attributes such as color intensity, texture, aroma, and taste, which are critical determinants of consumer acceptance. Previous studies have shown that the inclusion of vegetable powders in noodles can significantly affect sensory perception, highlighting the importance of comprehensive sensory evaluation (Chhikara et al., 2019; Kumar & Upadhyay, 2024).

Sensory evaluation is a scientific approach widely applied in food science to assess product quality and consumer acceptance. Among various sensory methods, scoring tests and hedonic tests are commonly used to evaluate different dimensions of sensory attributes. Scoring tests are applied to assess the degree of similarity between a test product and a reference or control sample, particularly for specific attributes such as texture and taste. In contrast, hedonic tests are designed to measure panelists' preference or level of liking toward sensory attributes including color, aroma, texture, taste, and overall acceptance (Meilgaard et al., 2016; Lawless & Heymann, 2010).

Despite the increasing application of beetroot in food products, studies specifically examining the sensory acceptance of beetroot powder based noodles, particularly using a combination of similarity-based scoring tests and preference based hedonic tests, remain limited. Therefore, the present study aims to evaluate the sensory acceptance of egg noodles formulated with beetroot powder using both scoring and hedonic organoleptic tests. This study focuses on assessing texture and taste similarity through scoring tests, as well as evaluating color, aroma, texture, taste, and overall acceptance through hedonic tests. The findings of this research are expected to support the development of beetroot based functional noodles that offer enhanced nutritional value while maintaining acceptable sensory quality.

2. MATERIAL AND METHODS

2.1 Research Design

This study employed a descriptive experimental design to evaluate the sensory acceptance of noodles fortified with beetroot powder (Beta vulgaris L.) through organoleptic testing, consisting of scoring and hedonic tests. Sensory evaluation was conducted to assess the similarity of the fortified noodles to the control sample as well as the level of panelists preference toward the sensory attributes of the product. This approach is commonly applied in food product development studies to evaluate sensory quality and consumer acceptance (Meilgaard, Civille, & Carr, 2016; Świąder, Marczewska, & Waleriańczyk, 2021).

2.2 Materials and Equipment

The materials used in this study consisted of high-protein wheat flour, tapioca flour, beetroot powder (Beta vulgaris L.), chicken eggs, salt, and water. All food ingredients were obtained from local markets and were of food grade quality.

The equipment used included a digital balance for weighing ingredients, mixing bowls for dough preparation, and a manual hand-cranked noodle machine for dough sheeting and noodle cutting. Cooking equipment such as a stove and cooking pot were used for noodle boiling. Measuring tools were utilized to ensure accurate liquid proportions. Organoleptic data were collected using evaluation sheets distributed through Google Forms, accessed via printed QR codes. Serving containers, forks, and drinking water were provided during sensory evaluation to facilitate sample presentation and palate neutralization.

2.3 Formulation of Beetroot Powder Based Noodles

The noodle formulation consisted of two formulations, namely a control formulation (F1) without beetroot powder and a treatment formulation (F2) with the addition of beetroot powder. The formulation was designed to evaluate the effect of beetroot powder incorporation on the sensory characteristics of noodles. The composition of each formulation is presented in Table 3.

Table 1 Formulation of Noodles Incorporated with Beetroot Powder

No.	Ingredient	Amount	
		F1	F2
1	High-protein wheat flour	200 g	200 g
2	Tapioca flour	30 g	30 g
3	Beetroot powder	-	5 g
4	Chicken egg	50-60 g	50-60 g
5	Salt	6 g	6 g
6	Water	60-70 ml	60-70 ml

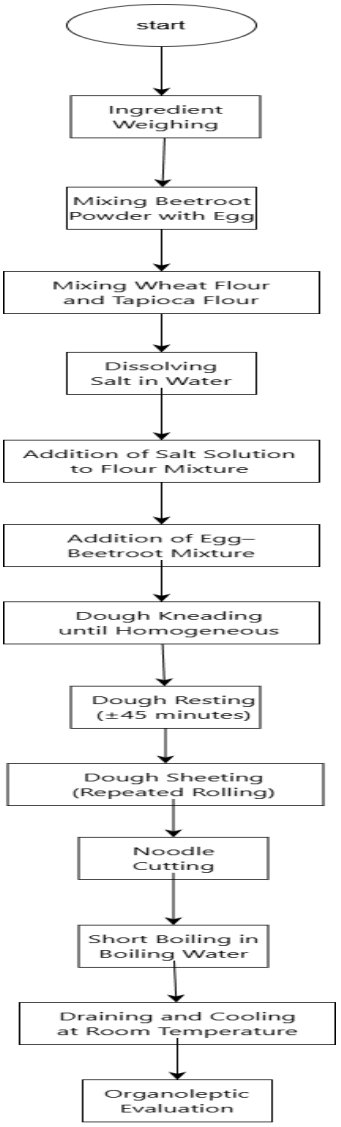
2.4 Noodle Preparation Procedure

The noodle preparation procedure followed the standard wet noodle production method with modifications in the incorporation of beetroot powder as a substitution ingredient.

The processing steps were as follows:

1. All ingredients were weighed according to the predetermined formulation.
2. Beetroot powder was first mixed with the egg and stirred until a homogeneous mixture was cooked noodles were drained and cooled at room temperature prior to organoleptic evaluation.

2.4.1 Flow Diagram



2.5 Sample Preparation for Sensory Evaluation

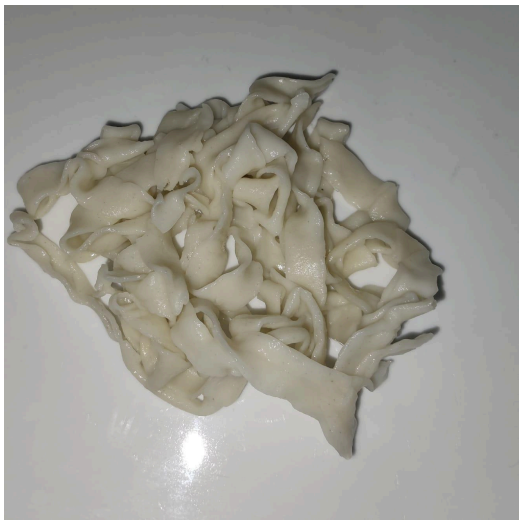


Figure 1. Appearance of control noodles (F1) used in the sensory evaluation.

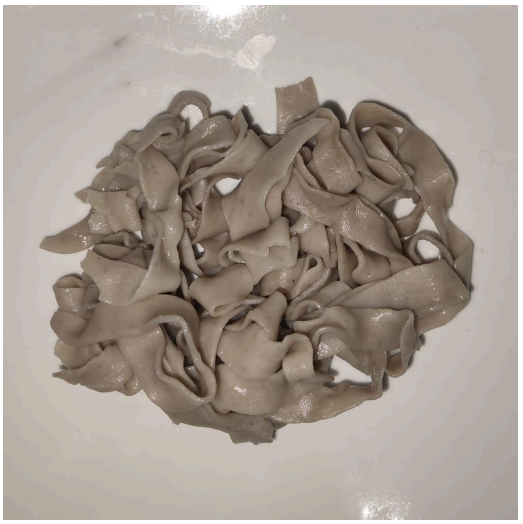


Figure 2. Appearance of beetroot powder based noodles (F2) used in the sensory evaluation.

2.6 Panelists

The organoleptic test was conducted using 15 semi trained panelists who met the criteria of normal health conditions and had no known food allergies related to the ingredients used in this study. The number of panelists employed was considered adequate for conducting hedonic and scoring tests in sensory evaluation.

2.7 Organoleptic Evaluation

2.7.1 Scoring Test

The scoring test was conducted to evaluate the degree of similarity between beetroot powder based noodles and control noodles. This test aimed to determine the effect of beetroot powder addition on the main sensory attributes of the noodle product compared to the control sample without beetroot powder.

The panelists involved in the scoring test were the same as those in the hedonic test, consisting of 15 untrained panelists with normal health conditions and no known food allergies related to the ingredients used in this study.

The sensory attributes evaluated in the scoring test included texture and taste. Panelists were asked to compare the beetroot powder based noodle sample with the control sample and assign a score based on the level of similarity.

The scoring test employed a 5-point scale, with the following criteria:

Table 2 Texture scoring scale

Score	Amount
1	very dissimilar to control (very non typical noodle taste)
2	dissimilar to control (non typical noodle taste)
3	slightly similar to control (moderately typical noodle taste)
4	similar to control (typical noodle taste)
5	very similar to control (very typical noodle taste)

Table 3 Taste scoring scale

Score	Amount
1	Very dissimilar to control
2	Not similar to control
3	Slightly to control
4	Similar to control
5	Very similar to control

During the evaluation, drinking water was provided to panelists to neutralize the palate before and after sample tasting. The scoring test data were analyzed descriptively to describe the similarity of sensory characteristics between the beetroot powder based noodles and the control noodles Scoring tests are used to assess specific sensory attributes based on the degree of conformity to a reference product (Meilgaard et al., 2016).

2.7.2 Hedonic Test

The hedonic test in this study was conducted to determine the level of panelists preference toward beetroot powder based noodles. Sensory evaluation was carried out based on the hedonic test method referring to SNI 2725.1:2009, with modifications in terms of the number of panelists and the scoring scale used.

A total of 15 untrained adult panelists participated in the hedonic test. All panelists were in normal health conditions and had no allergies to the food ingredients used in the study.

The noodle samples were served in ready to consume conditions. Panelists were asked to evaluate their level of preference for the sensory attributes of color, aroma, texture, taste, and overall acceptance. Drinking water was provided during the evaluation to neutralize the palate between samples.

The hedonic test used a 5 point hedonic scale, as shown in Table 3.

Table 4 Hedonic test scale

Score	Amount
1	Like very much
2	Like
3	Neutral
4	Dislike
5	Dislike very much

2.8 Data Analysis

The data obtained from the organoleptic tests (scoring and hedonic) were analyzed statistically using Analysis of Variance (ANOVA) at a 5% significance level ($\alpha = 0.05$). The analysis was performed to determine whether there were significant differences between the control sample (A1) and the beetroot powder based noodles (A2). If the calculated F-value was less than the F-table value ($p > 0.05$), the results were declared as non significant (ns), indicating no meaningful difference between the treatments. Data are presented as mean values ± standard deviation.

3. RESULTS AND DISCUSSION

3.1 Scoring Test of Texture and Taste

Table 5 Mean Scores of Texture and Taste Scoring Test of Beetroot Powder Fortified Egg Noodles

Sample	Scoring Test	
	Texture	Taste
A1 (Control)	3.27 ± 0.80[a]	3.80 ± 1.08[a]
A2 (Beetroot noodle)	3.60 ± 0.51[a]	3.07 ± 1.10[a]

Note. *Values are expressed as mean ± standard deviation.*
Values followed by the same superscript letter in the same column indicate no significant difference ($p > 0.05$).
A1 = egg noodles without beetroot powder; A2 = egg noodles with beetroot powder.
Texture scoring scale: (1) very not elastic, (2) not elastic, (3) slightly elastic, (4) elastic, (5) very elastic.
Taste scoring scale: (1) very not characteristic of egg noodles, (2) not characteristic, (3) slightly characteristic, (4) characteristic, (5) very characteristic.

3.2 Scoring Test of Texture and Taste

Table 6 Mean Hedonic Scores of Beetroot Powder Fortified Egg Noodles

Sample	hedonic test				
	Aroma	Color	Texture	Taste	Overall Acceptance
A1 (Control)	3.67 ± 0.90[a]	3.33 ± 0.72[a]	3.60 ± 0.91[a]	3.53 ± 0.92[a]	3.47 ± 0.83[a]
A2 (Beetroot noodle)	3.40 ± 0.91[a]	3.53 ± 0.99[a]	3.73 ± 0.59[a]	3.60 ± 0.91[a]	3.53 ± 0.92[a]

Note. *Values are expressed as mean ± standard deviation.*
Values followed by the same superscript letter in the same column indicate no significant difference ($p > 0.05$).
Hedonic scale: (1) dislike very much, (2) dislike, (3) slightly dislike, (4) neutral, (5) slightly like.

3.2 Discussion of Scoring Test on Texture and Taste

Based on the results of the scoring test presented in Table 5, the addition of beetroot powder to egg noodle formulation did not result in a significant difference in texture and taste compared to the control noodles ($p > 0.05$). The absence of a significant difference indicates that the incorporation of beetroot powder at the applied level was still able to maintain the essential sensory characteristics of conventional egg noodles.

The non significant difference observed in texture is closely related to the dominant role of gluten proteins from wheat flour and egg proteins in forming the structural matrix of egg noodles. Gluten contributes to the development of an elastic and cohesive network, which is responsible for the characteristic chewiness of noodles, while egg proteins enhance dough strength and structural stability during processing and cooking. The relatively low amount of beetroot powder added in this study was insufficient to disrupt the established gluten network, resulting in a texture that remained comparable to that of the control noodles (Chhikara et al., 2019; Pakhare et al., 2021).

Although not statistically significant, the mean texture score of noodles containing beetroot powder tended to be slightly higher than that of the control. This tendency may be associated with the dietary fiber content of beetroot powder, which has water-binding properties that can improve moisture retention and contribute to a softer and more elastic noodle texture. Dietary fiber has been reported to interact with protein starch matrices and enhance textural properties in noodle products (Pakhare et al., 2021).

With respect to taste, the control noodles showed a slightly higher mean score than noodles with beetroot powder; however, the difference was not significant. This finding suggests that the addition of beetroot powder at the tested level did not introduce undesirable flavors or alter the characteristic taste of egg noodles. The dominant taste profile of egg noodles is primarily derived from wheat flour and egg components, while beetroot powder mainly influences visual attributes rather than taste perception (Kumar & Upadhyay, 2024).

Overall, the scoring test results demonstrate that the addition of beetroot powder did not reduce the similarity of texture and taste between the modified noodles and the control product. Maintaining sensory similarity to conventional products is a critical factor in ensuring initial consumer acceptance of innovative noodle formulations.

3.3 Discussion of Hedonic Test

The hedonic test results shown in Table 6 indicate that noodles containing beetroot powder exhibited comparable levels of acceptance to the control noodles across all evaluated sensory attributes, including aroma, color, texture, taste, and overall acceptance ($p > 0.05$). The absence of significant differences suggests that panelists were able to accept noodles with beetroot powder addition without a reduction in overall liking.

The color attribute of noodles containing beetroot powder showed a slightly higher mean score compared to the control. This response is associated with the presence of betalain pigments in beetroot, which impart a natural reddish-purple hue to the noodles. Natural pigments derived from plant sources are generally perceived as more attractive and desirable by consumers, as they are often associated with naturalness and safety compared to synthetic colorants (Delgado Vargas et al., 2000; Chhikara et al., 2019).

For aroma and taste attributes, no significant differences were observed between the two formulations. This indicates that beetroot powder did not produce atypical aromas or flavors that could negatively affect consumer acceptance. The stability of aroma and taste is particularly important in the development of food

products incorporating plant based ingredients, as strong sensory deviations are a common cause of consumer rejection (Kumar & Upadhyay, 2024).

Texture and overall acceptance scores were also similar between noodles with beetroot powder and the control. These results further confirm that the structural characteristics of egg noodles, governed mainly by gluten and egg proteins, remained dominant despite the addition of beetroot powder. Comparable overall acceptance scores suggest that the formulation modification did not compromise consumer preference for the final product.

Although this study primarily focused on sensory evaluation, good sensory acceptance is a fundamental prerequisite for the development of functional food products. Functional foods can only be successfully introduced and widely consumed if they meet consumer expectations in terms of sensory quality. Therefore, the comparable sensory acceptance observed in noodles containing beetroot powder indicates their potential for further development as noodle products incorporating plant-based ingredients with natural pigments and bioactive compounds derived from beetroot (Chhikara et al., 2019; Pakhare et al., 2021).

4. CONCLUSIONS

The incorporation of beetroot powder into egg noodle formulation did not result in significant differences in sensory attributes based on both scoring and hedonic tests ($p > 0.05$). Beetroot powder fortified noodles exhibited texture and taste characteristics comparable to control noodles, as well as similar levels of consumer acceptance in terms of aroma, color, texture, taste, and overall preference. These results indicate that beetroot powder can be used as an alternative ingredient in egg noodle production without negatively affecting sensory quality, thereby offering potential for product diversification using plant-based ingredients.

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