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Exploring the acceptability of Kiwet (*Monopterus albus*) siomai among senior high school students

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Abstract
This study aims to introduce siomai products from the invasive Rice eel comparable to Tilapia. Utilizing it as the main ingredient in making siomai is necessary to increase its acceptability since it is considered a pest in rice fields in many parts of the Philippines. Senior high school students assessed the sensorial acceptability of the product in terms of appearance, aroma, color, taste, and texture using a hedonic scale. The acceptability composite index showed T2 ranked first, followed by T1, T4, and T3. This research gives significant conclusions that Kiwet siomai is comparable to Tilapia siomai, thus, further product development utilizing its by-product and investment opportunities in the food industry is recommended.

Keywords: Invasive species utilization, sensory evaluation, acceptability composite index

Introduction

The rising call for sustainable food sources has focused on invasive species use in lessening ecological impacts and providing safe, nutritious, and palatable food in attention. One of these interventions is Rice eel (*Monopterus albus*) into siomai, a popular Asian dumpling made traditionally with various meats including Tilapia. This research evaluates the acceptance of high school students for Rice eel siomai with different meat ratios and comparison to Tilapia siomai.

Invasive species are serious threats to their ecosystems which affects native biodiversity. To address this issue, it helps to control their populations by using it as a source of protein (Pasko *et al*., 2014) [10]. Earlier studies have indicated that consumer acceptance is paramount in the success of unconventional ingredients in producing food items (Ares *et al*., 2018) [2]. The acceptance depends on sensorial attributes such as appearance, aroma, color, taste, and texture (Lawless & Heymann, 2019) [9].

Rice eel is originally from Southeast Asia and has been described as invasive in different localities where it threatens local aquatic ecosystems (Fuller *et al*., 2018) [5]. It therefore offers an alternative source of protein sustainably, thus reducing the pressure felt on traditional fisheries (Godfray *et al*., 2018) [6]. However, studies have shown a growing demand for sustainable and environmentally friendly foods that meet sensory expectations (Tu *et al*., 2020) [15].

This research therefore aims to determine the acceptability of Rice eel siomai with varying ratios of its meat comparable to Tilapia siomai which is considered a typical Filipino fish dumpling. The study involves high school students as panelists to see if this new food finds its way into younger people's diets and future food trends (Spence *et al*., 2019) [12]. Such findings could impact sustainable food production and invasive species control strategies.

The main sensorial attributes to be investigated include the product's appearance, aroma, color, taste, and texture (Heng *et al*., 2007) [7]. The Acceptability Composite Index (ACI) is used to evaluate overall acceptability which incorporates the importance of each attribute weighted by panelists' perceptions.

Methods

1. Experimental organisms

Table 1: Experimental Treatments

Treatment	Description of the Treatment
T1	Tilapia siomai (Control)
T2	Rice eel siomai (E5%+R95%)
T3	Rice eel siomai (E15%+R85%)
T4	Rice eel siomai (E25%+R75%)

A total of 10 kilograms of Rice eel (Fig.1) were purchased live from a consolidator at San Mateo, Isabela, ranging from 200-250 grams each. The experimental treatments were shown in Table 1.

Fig 1: Rice eel *(Monopterus albus)*

2. Sample preparation

Newly acquired live rice eel was handled carefully and packed in an insulated container to prevent excessive mucus. To get rid of its mucus it was cleansed with wood ash and rinsed the eel thoroughly afterward to remove any residue. Cut the head, eviscerate, and completely drain its blood to remove the bad odor of the Rice eel. Then, the Rice eel flesh was cleansed using lemon to remove its fishy odor. Then, fillet to get the flesh and minced before processing.

3. Rice eel siomai processing

Table 2: Product formulation of Rice eel siomai in all treatments

Ingredients	Weight of ingredients in grams (g)			
	T1	T2	T3	T4
Tilapia meat	1000g	-	-	-
Rice eel meat	-	950g	850g	750g
Extender-cornstarch	-	50g	150g	250g
White sugar	50g	50g	50g	50g
Coarse salt	27.5g	27.5g	27.5g	27.5g
Sesame oil	4.55g	4.55g	4.55g	4.55g
Shrimp meat minced	250g	250g	250g	250g
Shrimp flavor	20g	20g	20g	20g
Jicamica chopped	130g	130g	130g	130g
Carrots minced	128g	128g	128g	128g
Egg	50g	50g	50g	50g
Molo wrapper	-	-	-	-
Total:	1,660.05 grams			

Product (Fig.3) was prepared following the Bureau of Fisheries and Aquatic Resources Region 02 procedure with slight modification (Fig.2). The ingredients were made into three different mixtures aside from the control, as shown in Table 2.

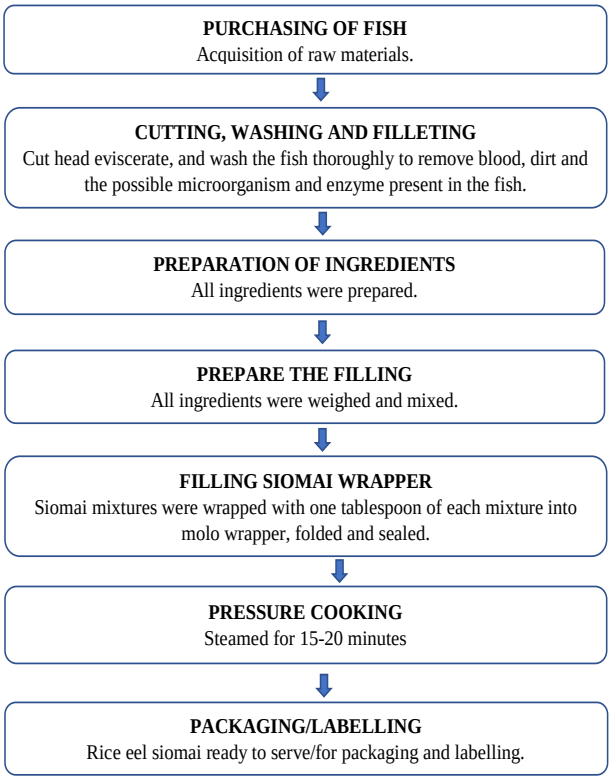

Fig 2: Schematic diagram of the cooking methods

Fig 3: Processed Product

4. Sensory Evaluation

The product assessment was to determine its acceptability on appearance, aroma, color, taste, and texture. Fifteen (15) senior high school student semi-trained panelists were chosen to evaluate the acceptability of the products representing males and females using the 9-point hedonic scale (Table 3).

5. Acceptability Composite Index (ACI)

The acceptability composite index is a procedure to follow and determine the general acceptability of the product by ranking each treatment. The percentage in each criterion was computed by receiving the panels' recommended allotted percentage. ACI procedure is based on Reyes (2019) [13].

6. Statistical analysis

The weighted means of each treatment was calculated using IBM SPSS Statistics V21.0 on One-way Analysis of Variance (ANOVA) used to examine the acceptability of Rice eel siomai in terms of appearance, aroma, color, taste, and texture at the $p<0.05$ level of significance.

Results and Discussion

1. Quality attributes on the general acceptability of Rice eel siomai

1.1. Appearance acceptability

The mean hedonic appearance scores for each treatment shown in Table 4 were recorded as follows: T1 with 7.93, T2 with 8.33, T3 with 7.73, and T4 with 8.20. These scores were interpreted using the Likert scale, where "LVM" means a like very much interpretation and "LE" means a like extremely. From the scores, T2 scored the highest mean hedonic appearance with an adjectival rating of "LE" followed by T4 "LE", T1 "LVM", and T3 "LVM". However, there were no significant differences among treatments in terms of appearance. This means that the varying meat proportions of Rice eel siomai did not affect the product's appearance.

All the treatments were well accepted visually, as indicated by the mean hedonic scores for appearance that ranged from 7.73 to 8.33. The highest score was recorded by T2 (Rice eel siomai with E5%+R95%) which had an adjectival rating of "Like Extremely" (LE) followed closely by other treatments. This implies that meat proportions used in the preparation of siomai were appealing based on this evidence of consistency across scores. There is much emphasis on how appealing food products should appear as it plays a key role in consumer acceptance which supports our findings according to current literature by Tu *et al*., (2018) [14], the food appearance significantly influences consumer preference and initial trial.

1.2. Aroma Acceptability

The mean hedonic aroma scores for each treatment shown in Table 4 were recorded as follows: T1 with 7.60, T2 with 8.00, T3 with 6.93, and T4 with 7.87. These scores were interpreted by the use of the Likert scale, where "LVM" means "Like Very Much" and "LM" means "Like Moderately". From the scores, T2 scored the highest mean hedonic aroma with an adjectival rating of "LVM" followed by T4 "LVM", T1 "LVM", and T3 "LM". However, there were no significant differences among treatments in terms of aroma. This means that the varying meat proportions of

Rice eel siomai did not affect the product's aroma against Tilapia siomai.

Treatment 2 got the highest acceptance with 8.00, while T4, T1, and T3 followed suit in that order from the aroma scores. Despite having different scores, all the treatments were rated positively which showed that the inclusion of Rice eel has no negative impact on siomai aroma. Recent findings suggest that food product flavors can be maintained or even improved by adding new components so long as their flavors are maintained according to Cardello *et al*., (2016) [3].

1.3. Color Acceptability

The mean hedonic color scores for each treatment shown in Table 4 were recorded as follows: T1 with 7.80, T2 with 8.13, T3 with 7.53, and T4 with 8.20. These scores were interpreted by the use of the Likert scale, where "LVM" means "Like Very Much" and "LE" means "Like Extremely". From the scores, T4 scored the highest mean hedonic color with an adjectival rating of "LE" followed by T2 "LE", T1 "LVM", and T3 "LM". However, there were no significant differences among treatments in terms of color. This means that the varying meat proportions of Rice eel siomai did not affect the product's color against Tilapia siomai.

Results of color acceptability scores indicated that T4 (Rice eel siomai with E25%+R75%) was the highest rated, followed closely by T2. This implies that greater Rice eel proportions in the siomai have not diminished its attractiveness. Freshness and quality are influenced by color, an important attribute observed according to Spence *et al*., (2015) [11]. Across treatment consistency in color acceptability suggests that the visual quality of siomai is not sacrificed when using Rice eel.

1.4. Taste acceptability

The mean hedonic color scores for each treatment shown in Table 4 were recorded as follows: T1 with 8.07, T2 with 8.07, T3 with 7.13, and T4 with 8.00. These scores were interpreted by the use of the Likert scale, where "LVM" means "Like Very Much" and "LM" means "Like Moderately". From the scores, T1 and T2 scored the highest mean hedonic taste with an adjectival rating of "LVM" followed by T4 "LVM", and T3 "LM". However, there were no significant differences among treatments in terms of taste. This means that the varying meat proportions of Rice eel siomai did not affect the product's taste against Tilapia siomai.

For taste, T1 (Tilapia siomai as control) and T2 (Rice eel siomai) scored the highest, both with an average hedonic score of 8.07. Taste determines food preference, hence, maintaining high taste acceptability is central to successful adoption of new food products according to Lawless & Heymann (2010) [8]. Also, recent studies indicate that well-balanced taste profiles in novel food products can lead to their high acceptance among consumers (Ares *et al*., 2016) [1].

1.5. Texture acceptability

The mean hedonic color scores for each treatment shown in Table 4 were recorded as follows: T1 with 7.53, T2 with 7.80, T3 with 7.67, and T4 with 7.67 These scores were interpreted by the use of the Likert scale, where "LVM" means "Like Very Much". From the scores, T2 scored the highest mean hedonic taste with an adjectival rating of "LVM" followed by T3 and T4 "LVM", and T1 "LVM". However, there were no significant differences among treatments in terms of texture. This means that the varying meat proportions of Rice eel siomai did not affect the product's texture against Tilapia siomai.

Acceptable levels of texture were obtained for all treatments with T2 performing the best among them. Texture is a key perception that influences the eating experience and overall satisfaction of consumers with food products. According to Chen & Opara (2013) [4], several studies have suggested that an acceptable texture is crucial in new food product development.

This research indicates that Rice eel can be successfully incorporated into siomai at different levels without negatively affecting some essential sensory attributes such as appearance, aroma, color, taste, and texture. Therefore, this finding is important because it forms a basis for producing alternative protein sources-based siomai which may attract customers looking forward to variation or specific health benefits from proteins. The idea of using Rice eel in siomai making can also be viewed as part of the global trend toward sustainable and more diverse protein sources within the food industry according to Godfray *et al*., (2018) [6].

Table 4: Mean scores of Rice eel siomai in all sensorial attributes based on hedonic scale

Sensorial attribute	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Appearance	7.93±1.10^{a} LVM	8.33±0.72^{a} LE	7.73±1.28^{a} LVM	8.20±1.15^{a} LE
Aroma	7.60±1.64^{a} LVM	8.00±1.41^{a} LVM	6.93±2.09^{a} LM	7.87±1.19^{a} LVM
Color	7.80±0.94^{a} LVM	8.13±0.92^{a} LE	7.53±1.46^{a} LVM	8.20±1.01^{a} LE
Taste	8.07±1.49^{a} LVM	8.07±1.16^{a} LVM	7.13±1.60^{a} LM	8.00±1.07^{a} LVM
Texture	7.53±0.92^{a} LVM	7.80±1.01^{a} LVM	7.67±1.35^{a} LVM	7.67±0.98^{a} LVM

Note: Means with superscript letters indicate significant differences between the groups at $p < 0.05$

1.6. General Acceptability of the product based on the Acceptability Composite Index (ACI)

Table 5 shows the Acceptability Composite Index of the product in general terms of appearance, aroma, color, taste, and texture. The given percentages of each sensorial attribute for appearance, aroma, color, taste, and texture are 21.90%, 18.23%, 19.32%, 21.50%, and 19.02%, respectively. The criteria of the allotted percentage are based on the computed recommended allotted percentages of the 15 high school student panelists. T2 got the highest score in overall acceptability with a score of 8.1 and placed top rank among all treatments with an adjectival rating of like very much (LVM), followed by T4 gained with 8.0 score with an adjectival rating of LVM, placing it second. The control (T1) gains an overall acceptability score rating of 7.8 with an adjectival rating of LVM placing the treatment in third. T3 had the lowest overall acceptability score rating with a rating of 7.4 with an adjectival rating of like very much (LVM) and was ranked fourth. The results therefore suggested that among the siomai treatments, Rice eel siomai, T2, T3, and T4 performed well in overall acceptability comparable to the Tilapia siomai (T1).

Based on the total ACI scores, T2 had the highest overall acceptance, followed by T4, T1, and T3 with 8.1, 8.0, 7.8, and 7.4 ratings respectively. These results suggest that Rice eel siomai especially the T2 recipe is well accepted by consumers as evidenced by its impressive performance in all sensory attributes investigated. This information is important in incorporating Rice eel into siomai since it supports the idea of protein sources sustainability while maintaining taste quality per current global dietary preferences according to Godfray *et al*., (2018) [6].

Table 5: Acceptability Composite Index (ACI) for general acceptability of the processed product

Sensorial Attributes	Treatments			
	T1	T2	T3	T4
Appearance (21.90%)	1.7	1.8	1.7	1.8
Aroma (18.23%)	1.4	1.5	1.3	1.4
Color (19.32%)	1.5	1.6	1.5	1.6
Taste (21.50%)	1.7	1.7	1.5	1.7
Texture (19.02%)	1.4	1.5	1.5	1.5
Total ACI	7.8	8.1	7.4	8.0
Rank	3	1	4	2

Conclusion and Future Works

This study revealed that Rice eel can processed into siomai comparable to the existing Tilapia siomai product in the fisheries sector, it is generally acceptable in terms of appearance, aroma, color, taste, and texture in high school students. The p-values obtained for each attribute were above the significant level ($p>0.05$), suggesting that the observed differences in group means were not statistically significant against the control. Aside from that, the Acceptability Composite Index (ACI) showed that among other treatments on sensory attributes and overall acceptability, the Rice eel siomai especially T2 was ranked first. These results support the potential for Rice eel as a sustainable and acceptable ingredient in siomai production, hence, further studies on the waste utilization of Rice eel are recommended.

Ethical Considerations

The authors obtained informed consent from all participants. This was done before their inclusion in the study.

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