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Sensory Evaluation of Vacuum-packed Rice eel (*Monopterus albus*) Fillet Marinade

Evelyn S. Talla[1,2*]; Marites R. Castro[1]; Mary Joy L. Asprec[1]; Isagani P. Angeles[1]; Evelyn C. Ame[2]; Emma L. Ballad[2]

[1]Provincial Institute of Fisheries, Isabela State University, Roxas, Isabela 3320 Philippines,
[2]Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Tuguegarao City, Cagayan 3500 Philippines

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Abstract

This study focused on the formulation of a good marinate substitute for vacuum-packed fillets. Treatment marinates are vinegar (T1), lemon juice (T2), *calamansi* juice (T3), and sweet orange juice (T4), with the same amount of salt, garlic powder, white pepper, and chili powder. Acceptability was determined by its sensory attributes such as taste, odor, color, texture, and Acceptability Composite Index. Results revealed that T 2 (rice eel fillet marinated with 75 ml lemon juice is the most acceptable treatment among the four treatments. In the sensory acceptability, there are no significant differences in the product's hedonic odor, taste, and texture among the four treatments. However, there is a significant difference in the hedonic color of the product among the 4 treatments. Different marinades can be developed for rice eel to improve its taste and acceptability in terms of color, aroma, and texture.

Keywords: *Rice eel fillet, Marinades, Sensory Evaluation.*

I. INTRODUCTION

Monopterus albus, also known as the Asian swamp eel or rice eel, is extensively distributed throughout Asia, from northern India and Burma to China, Asiatic Russia, Japan, and the Indo-Malayan Archipelago. It is an economical fish in Philippines (Silva et al., 2020), Vietnam (Khanh and Ngan, 2010), Thailand (Amornsakun et al., 2018), China (Yang et al., 2018), and Indonesia (Herawati et al., 2018) because of its flavor and nutritional composition. This species commonly known as "*Kiwet*" was introduced in the Philippines in 1905 as a species for aquaculture without an in-depth evaluation of its probable negative impact on the environment. In the Cagayan Valley Region, it is being considered a pest because of the economic loss it brought to farmers boring holes in the dikes and drains the water from the rice field, thus, contributing to the extra expense of the farmers. These non-native fish species, which grow 25-40 centimeters into maturity, reportedly destroy rice paddies by digging themselves in the soil, loosening its structure, and causing water irrigation to leak off. To address the problem on infestation, the Bureau of Fisheries and Aquatic Resources (BFAR) Region 02 initiated the processing of Rice eels. Rice eels were processed into different value-added products such as nuggets, spring rolls, smoked eels, and *longaniza* (Nitura, 2016).

The *Citrus limon* (L.) Burm., commonly known as the lemon tree is a species from the family Rutaceae that is native to Asia. Lemon fruit is a great source of nutrients with lots of health benefits. It is a rich source of many nutrients and unique flavor, it is widely known to improve the consumer's health. Lemon juice, a main source of acidulant citric acid, is often used in the preparation of cultural foods.

Sweet orange (*Citrus sinensis* L. Osbeck), it is one of the most important crops in the world, it is mostly used for the consumption of its freshly extracted juice. It is a good source of vitamin C, a natural antioxidant that supports immune system activity. It has been traditionally used as treatment for intestinal problems, respiratory, obesity, menstrual illness, cardiovascular ailment, anxiety, stress, and even depression (Mannucci et al., 2018).

Calamansi (*Citrus microcarpa* B.) is a citrus from the Philippines which is essential oil-rich and commonly used in beverages and condiments. It has gained popularity in the flavor industry and is significant in the Filipino culinary tradition because of its pleasing flavor profile and naturalness (Fan et al., 2015).

Marinating is a method of fish preservation using common salt and acetic acid along with condiments and spices. The salt and acetic acid protects the fish products

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from infection and the development of microbes. In addition, the shelf life of fresh meat has been recommended to increase using marinating processes, because the acidic or alkaline nature of the solution and the antimicrobial or antioxidant activities of some marinade additives can perform to preserve meat or reduce the growth of bacteria (Sikorski, 1990),

New product development (NPD) is "the process of creating a new product, manufacturing it, and bringing it to market". Sensory evaluation and new product development are deeply connected. Sensory analysis methods can be used at many stages of the design process to evaluate the quality of the product, the expectations of consumers and their responses to the product. Sensory evaluation is defined as a scientific discipline used to measure, evoke, analyze, and interpret reactions to those characteristics of foods and materials as they are perceived by the five senses (Świąder & Marczewska, 2021).

Value-added processing will play an important role in the growing aquaculture sector to help reach the demands of the consumer for wholesome, safe, and high-quality seafood products (Morissey, 2013).

This study has tested different marinates to add value to Rice eel that is pleasing and desirable for local markets and to the liking of local consumers.

The main objective of the study is to develop a new vacuum-packed rice eel fillet marinade that can be stored frozen. It specifically aims to determine the general acceptability of the different marinades through sensory evaluation using the Hedonic Scale and Acceptability Composite Index (ACI).

II. MATERIALS AND METHODS

A. Experimental Species and Preparartions

In this study, the rice eel at approximately 200 grams per piece was used as the raw material to produce marinated rice eel fillets. It was purchased in Solana, Cagayan. Fish was placed in cooler boxes and transported to the Bureau of Fisheries and Aquatic Resources-Regional Office No. 02, Tuguegarao City, Cagayan. The fish were first acclimatized for about 10-20 minutes to avoid stress. A total of 10 kilograms of Rice eel was used in the whole experiment. The experimental species was conditioned for 24 hours before cleaning and washing.

B. Experimental Treatments

The ingredients and experimental treatments used in this study are shown in Table 1 and described in Table 2. It was based on the study of Rathnayake et al. (2012), with some modifications on the ratio of fish to marinating solution to Rice eel fillet (1:0.75).

Table 1. The Ingredients and Measurements Used in the Study

Ingredients	T1 (Control)	T2	T3	T4
Rice eel fillet (g)	100	100	100	100
Marinating solution				
Vinegar (ml)	75	0	0	0
Lemon juice (ml)	0	75	0	0
Calamansi juice (ml)	0	0	75	0
Sweet Orange juice (ml)	0	0	0	75
Salt (g)	5	5	5	5
Garlic powder (g)	5	5	5	5
Ground white pepper (g)	5	5	5	5
Chili powder(g)	5	5	5	5

Table 2. Description of the Experimental Treatment

Treatment	Description
T 1 Control)	Rice eel fillet marinated in vinegar
T 2	Rice eel fillet marinated in lemon juice
T 3	Rice eel fillet marinated in calamansi juice
T 4	Rice eel fillet marinated in sweet orange juice

C. Marinating Procedure

The Rice eel was washed and cleaned thoroughly using tap water. After washing, its head was removed and the blood out, followed by cutting into split form and deboned, the internal organs were also removed. The fillet was washed and drained then it was soaked in a marinating solution per treatment for 30 minutes. Vacuum-packed, labeled and stored at ¯18˚C.

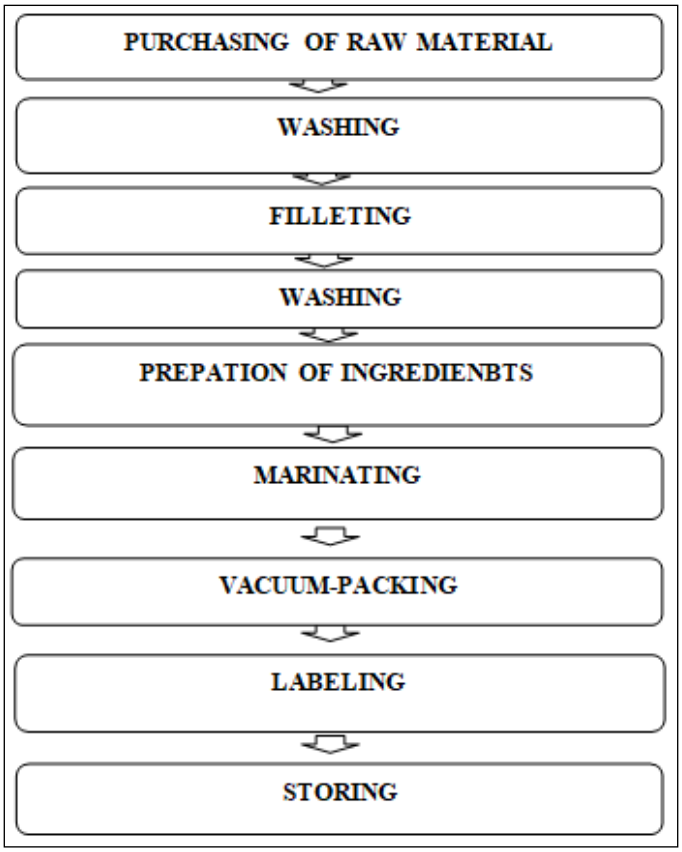

Fig 1. Process Flow of Making Vacuum-Packed Rice eel Fillet Marinade

D. Cooking after marinating

After marinating, the fish was cooked in medium heat for 10 minutes before sensory evaluation with new cooking oil per sample.

E. Sensory Evaluation

Sensory evaluation was conducted to determine the appearance, color, odor, texture, taste qualities, and general acceptability of frozen vacuum-packed Rice eel fillet using fifty (50) semi-trained panelists of different ages and genders. Four representative fish samples from different treatments were individually presented to each panelist. The judges were uninformed about the experimental approach, and the samples were blind-coded using a combination of numbers and letters. Panelists were instructed to drink water as palate cleansers and to pause for at least 30 seconds between samples. They were asked to evaluate the products based on odor, color, texture, taste, and general acceptability. The 9-point hedonic scale and Acceptability Composite Index (ACI) were used to assess sensory qualities and the overall acceptability of the products.

Allow to cool at room temperature (28-30 ^{o}C)

F. Acceptability Composite Index

ACI is a procedure in determining the general acceptability of the product by ranking each treatment. The percentage in every criterion was computed by receiving the recommended allotted percentage of the panels. The ACI will be the average percentage of each criterion among treatment.

G. Statistical Analysis

Data gathered was tabulated and treated using the Analysis of Variance (ANOVA) at $p<0.05$ level of significance. ANOVA was used to determine the significant differences among the treatments. Tukey B was used to determine the degree of variance among the samples.

III. RESULTS AND DISCUSSION

A. Color Acceptability

Based on the hedonic score, T1 got the highest score of 7.68 which is described as “Like Very Much”, followed by T2 with a score of 7.38, T3 which is 7.26, and last is T4 with a score of 6.96. T2, T3, and T4 were all described as "Like Moderately" by the panelists as shown in Table 3.

Table 3. Color Acceptability of Vacuum-packed Rice eel fillet marinade

Treatment	Description	Hedonic Color	Interpretation
1	Vinegar	7.68 ± 0.935	LVM
2	Lemon Juice	7.38 ± 1.028	LM
3	Calamansi Juice	7.26 ± 1.084	LM
4	Sweet Orange Juice	6.96 ± 1.142	LM
Grand Mean		**7.32 ± 1.074**	

Note: Means with different superscript letters represent significant difference between groups at p<0.05.

B. Odor Acceptability

Based on the hedonic score, T2 got the highest score of 7.66 which is equivalent to "Very Much Pleasant", followed by T4 with a score of 7.54 which is also described as very much pleasant, T1 which is 7.44 "moderately pleasant" and last is T3 with a score of 7.26, also "Moderately Pleasant" as shown in Table 4.

Table 4. Texture Acceptability of Vacuum-packed Rice eel Fillet Marinade

Treatment	Description	Hedonic Odor	Interpretation
1	Vinegar	7.44 ± 1.072	MP
2	Lemon Juice	7.66 ± .962	VMP
3	Calamansi Juice	7.26 ± 1.242	MP
4	Sweet Orange Juice	7.54 ± 1.054	VMP
Grand Mean		**7.48 ± 1.089**	

Note: Means with different superscript letters represent significant difference between groups at p<0.05.

C. Texture Acceptability

Based on the hedonic score, T1 got the highest score of 7.34 which is equivalent to "Liked Moderately", followed by T2 with a score of 7.24 which is also described as "Liked Moderately", T3 and T4 tied with a score of 7.2 which is also "Liked Moderately" as shown in Table 5.

Based on the hedonic score, T1 got the highest score of 7.34 which is equivalent to "Liked Moderately", followed by T2 with a score of 7.24 which is also described as "Liked Moderately", T3 and T4 tied with a score of 7.2 which is also "Liked Moderately" as shown in Table 5.

Table 5. Texture Acceptability of Vacuum-packed Rice eel fillet marinade

Treatment	Description	Hedonic Texture	Interpretation
1	Vinegar	7.34 ± 1.099	LM
2	Lemon Juice	7.24 ± 1.170	LM
3	Calamansi Juice	7.22 ± 1.148	LM
4	Sweet Orange Juice	7.22 ± 1.093	LM
Grand Mean		**7.26 ± 1.121**	

Note: Means with different superscript letters represent significant difference between groups at p<0.05.

D.Taste Acceptability

Based on the hedonic score, T4 got the highest score of 7.68 which is described as "Extremely Good", followed by T2 with a score of 7.44, "Moderately Good", T1 which is 7.28, "Moderately Good" and last is T3 with a score of 7.16, also "Moderately Good" as shown in Table 5.

Table 6. Taste Acceptability of Vacuum-packed Rice eel Fillet Marinade

Treatment	Description	Hedonic Taste	Interpretation
1	Vinegar	7.28 ± .970	MG
2	Lemon Juice	7.44 ± 1.248	MG
3	Calamansi Juice	7.16 ± 1.267	MG
4	Sweet Orange Juice	7.68 ± 1.077	VMG
Grand Mean		**7.39 ± 1.155**	

Note: Means with different superscript letters represent significant difference between groups at p<0.05.

E. Acceptability Composite Index

The Acceptability Composite Index (ACI) was used to determine the general acceptability of the product. Table 7 shows the mean acceptability of each treatment based on the score sheets rated by 50 panelists. The result of the Acceptability Composite Index (ACI) reveals that treatment 2 (Rice eel fillet marinated with lemon juice) is the most acceptable treatment among the four

treatments with 7.44 ACI, followed by Treatment 1 (vinegar) and treatment 4 (Sweet orange) with 7.44 ACI and treatment 3 (calamansi) the lowest ACI of 7.21.

Table 7. Acceptability Composite Index of Vacuum-packed Rice eel Fillet Marinade

Trt	Hedonic Color	Color 20.5%	Hedonic Odor	Aroma 22.2%	Hedonic Texture		Texture 20.1%	Hedonic Taste	Taste 37.2%	Total ACI	Rank
1	7.68	1.57	7.44	1.65	7.34		1.48	7.28	2.71	7.41	**2.5**
2	7.38	1.51	7.66	1.70	7.24		1.46	7.44	2.77	7.44	**1**
3	7.26	1.49	7.26	1.61	7.22		1.45	7.16	2.66	7.21	**4**
4	6.96	1.43	7.54	1.67	7.22		1.45	7.68	2.86	7.41	**2.5**

** T_1-Control T_2-Lemon Juice T_3-Calamansi Juice T_4-Orange Juice*

The sensory characteristics of vacuum-packed Rice eel fillet marinade using fruit juices such as lemon, sweet orange and calamansi were carried out using a 9-point hedonic scale. It was evaluated by 50 semi-trained panelists from BFAR RO2 staff and OJTs in terms of different quality attributes (color, odor, texture, taste and general acceptability).

A one-way analysis of variance (ANOVA) was conducted to explore the differences in the hedonic color, aroma, texture, and taste of the product among the four treatments (T1: Vinegar; T2: Lemon Juice; T3: Calamansi Juice; and, T4: Sweet Orange juice), as shown in Tables 3,4,5 and 6.

The results showed that there are no significant differences in the hedonic odor, taste, and texture of the product among the four treatments. This implies that the treatments used in the product do not necessarily affect its hedonic odor, texture, and taste.

However, there is a significant difference in the hedonic color of the product among the four treatments, F (2,245) = 4.025, $p < .01$. The difference in the mean score between the groups was large, $\eta^2 = 0.05$. Hence, there is a large effect size in the mean difference. A post-hoc comparison using the Tukey HSD procedure indicated that the mean score of T1 is significantly different from T4, but not significantly different from T2, and T3. Since Treatment 1 has the highest mean score (M = 7.68, SD = 0.935) among the other treatments, it can be concluded that T1 is the best treatment for the hedonic color of the product.

The result of the hedonic acceptability of this study shows that the odor of the Rice Eel Fillet marinated with lemon juice (T2) got the highest acceptability among all treatments which is described as “Like Very Much”. Fresh lemon juice is a good natural choice for marinating processes. It has these contents all of which have health-promoting properties and antioxidant effects, has about 3% sugar content, ascorbic acid, minerals like potassium, and phenolics (Gonzales-Molina et al., 2009). In cooking, citrus is often used to enhance flavors and work well to counter many of the salty and sea weedy flavors present in seafoods. This is why fish and lemon are fit together. The acid and the salt balance each other while doing a little flavor on the palate.

Based on the acceptability composite index, frozen rice eel fillet marinated with lemon juice got the highest mean average which means that it is the most generally acceptable among the four treatments based on the preference of the panelists. Lemons has lots of benefits as are also an interesting source of flavonoids, vitamins, minerals, dietary fibers, essential oils, organic acids, and carotenoids. While bringing out the fish's innate sweetness, the acidity of the lemon helps to cut through the oils and fat present in the fish. In addition, the lemon zest and juice give the fish meat a light citrus flavor.

The results support the findings of (Mustafa et al. 2023) on the quality parameters of common carp (*Cyprinus carpio*) meat marinated with the traditional method used in Anatolia during storage at −18 °C. It showed that the panelists preferred the carp meat marinated with lemon juice.

IV. CONCLUSION

Based on the results of the study, the following conclusions were drawn:

- In the sensory acceptability, there are no significant differences in the hedonic odor, taste, and texture of the product among the four treatments. This implies that the treatments used in the product do not necessarily affect its hedonic odor, texture and taste. However, there is a significant difference in the hedonic color of the product among the 4 treatments.
- The general acceptability of the product was determined, and frozen rice eel fillet marinated with lemon juice was the most accepted by the panelists based on the ACI total ranking.

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