

## Acceptability of mexican-style chorizo sausage using rice Eel (*Monopterus albus*) meat

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### Abstract

Rice eel is regarded as nuisance and pest and has low acceptance to consumers for household consumption due to its slimy, fishy taste and fishy odor characteristics. Therefore, ways to add value to rice eel, as a raw material in the production of ready-to-eat products, are of great interest, to offer value-added products and to address sustainability. Mexican-style chorizo (MSC) sausage using Rice eel meat was produced. The spices which create flavorful and spicy characteristics of the MSC sausage could remove fishy odor and taste of rice eel thus, increasing its commercial value as a food commodity. Four formulations of Mexican-style chorizo sausage with 100%, 75%, 50% and 25% rice eel meat were evaluated for sensory acceptability for the attributes appearance, odor, flavor and texture by fifty (50) semi-trained panelist using 9-point hedonic scale. Acceptability Composite Index (ACI) was used to determine the ranking of each treatment. Results showed that MSC sausage with 75% Rice eel meat (T2) got the highest acceptable score in the attributes appearance and flavor while MSC sausage with 25% Rice eel meat (T4) got the highest acceptable score in the attribute odor and MSC sausage with 100% Rice eel meat (T1) in the attribute texture. The ACI confirms that chorizo sausage with 75% Rice eel meat (T2) is the most acceptable treatment among the group.

**Keywords:** Rice eel chorizo sausage, sensory evaluation, sustainable food, healthy choices, improved nutrition

### Introduction

The Rice eel (*Monopterus albus*) locally known as “kiwet” in the Philippines are among the introduced fish species supposed to be for aquaculture in the Philippines (Guerrero, 2014) [8]. It belongs to the family Synbranchidae in the order Synbranchiformes (FISHBASE). They inhabit muddy substrates in marshes, rice paddies, ponds, and slow-flowing streams (Matsumoto *et al.*, 2009) [13]. However, they have been reported to infest rice fields affecting rice farming operations in Cagayan Valley Region particularly in the provinces of Quirino and Nueva Vizcaya since 2011 (Guerrero, 2014; DA-BFAR, 2013) [8]. They have since found in the rice fields and fishponds in nearby provinces of Isabela, Cagayan, and Ifugao. They have also been found 300 km south of Cagayan in the provinces of Cavite and Laguna (Santiaguel n.d.). Other PhilRice stations also reported the presence of rice eel in the rice fields of Negros Occidental (Roque n.d.).

In order to address this issue, the DA-Bureau of Fisheries and Aquatic Resources (DA-BFAR) Region 2 initiated the development and processing of this invasive fish to show that fish like rice eel which is considered a menace and pest by farmers can have a significant value as a delicacy food. This fish can be an interesting alternative source of protein. Among the various traditional meat products in the market, sausages are especially suited – given their organoleptic and technological characteristics – for experimenting meat replacement by fish (Kahraman *et al.*, 2013) [11].

Freshwater swamp eels are potential as protein source. It is also rich in essential nutrients, hence, become a healthy food. It promotes healthy eyesight, nervous system function and normal brain development. Though many people are hesitant to eat eels, this species is evidently nutritious (Silva *et al.*, 2020) [25]. Therefore, ways to add value to rice eel, as a raw material in the production of ready-to-eat products, are of great interest, in order to offer value-added products and to address sustainability.

Fish products such as sausages, salamis, frankfurthers, burgers, and kebabs have been the subject of research in recent years, particularly in the countries of eastern Asia and in several other countries around the world (Kašpar *et al.*, 2015). These fish products can cater to the growing demand for convenience foods and healthy eating options and increasing consumer demand. Several fish sausages have been made from different fish species like production of Chinese-style fish sausage from hybrid clarias catfish (Nongnuch *et al.*, 2004). Fish sausages were also successfully prepared using tilapia (Ramirez, 2022) [19], carp (Kašpar, 2015) and shark meat (Kahraman *et al.*, 2013) [11] among others. Researchers have also successfully formulated mexican-style chorizo sausage using invasive silver carp (Trindade *et al.*, 2019).

Chorizo is a dry-cured sausage which is appreciated for its colour, aroma and flavour (Sánchez-Zapata, 2013) [22]. Mexican-style chorizo (MSC) is a soft-sausage usually bright or dark red in color prepared with minced pork and fat and is seasoned with spices. This sausage is kept in manufacturing and retail establishments for periods ranging from hours to weeks after casing, under non-uniform conditions, i.e., refrigeration or room temperature (González-Tenorio *et al.*, 2013) [7].

The development of MSC sausage using rice eel meat aims to further utilize the abundant supply of such species in the Cagayan Valley Region. With the spices that create spicy and flavorful characteristics of the MSC sausage could remove fishy odor and taste of rice eel and increase its commercial value as a food commodity. Development of such product will be a way of reaching variety of consumers specifically the health-conscious ones. The objectives of this study were to assess the sensory acceptability of Mexican-style chorizo sausages made from rice eel meat in terms of appearance, odor, flavor, and texture attributes, as well as to determine their ranking using the Acceptability Composite Index.

**Methods**

**1. Preparation of raw materials**

A total of 5 kilograms Rice eel with a weight ranging from 150-200 grams per piece was purchased live from a rice eel collector in Solana, Cagayan, Philippines. The fish was transported to the Integrated Fish Processing Laboratory, DA- Bureau of Fisheries and Aquatic Resources Regional Office No. 02, Tuguegarao City, Cagayan, Philippines. The rice eel was beheaded, gutted, skinned, filleted, washed and packed in ice until used. The ingredients such as cornstarch, salt, garlic powder, guajillo chili pepper powder, cumin, black pepper, paprika and pig intestine casing were purchased from a local market.

**2. Experimental treatment**

There are 5 treatments in this study. The different treatments are presented in Table 1.

**Table 1.** Different treatments of MSC sausage using various proportions of rice eel meat

Treatment	Description
T1 (control)	100% Rice eel meat
T2	75% Rice eel meat
T3	50% Rice eel meat
T4	25% Rice eel meat

**3. Formulations**

The formulations for fish chorizo sausage with various proportions of rice eel meat (100%, 75%, 50%, 25%) were modified from Chuapoejuk *et al.*, (2001) [5], Prabpree and Pongsawatmanit (2011) [17], and Hew *et al.*, (2005) [10]. Cornstarch was used as extender. The other ingredients used in the preparation of sausages were added in the treatments at the same proportions. Treatments were processed following the formulations given in Table 1.

**Table 2:** Formulations of mexican-style chorizo sausage (100g)

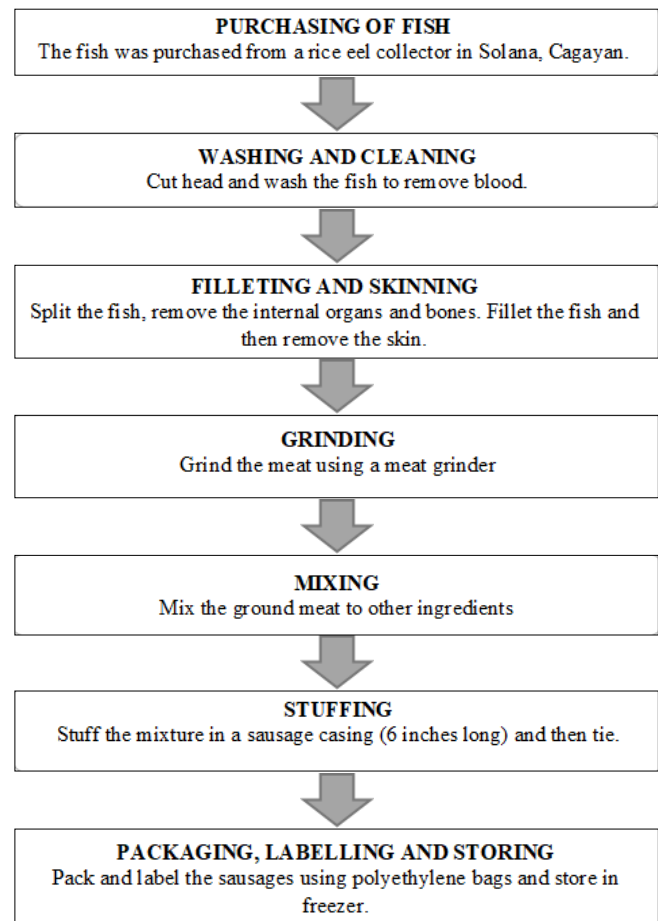
Ingredients	Rice eel meat to cornstarch proportions			
	T1(control) 100%	T2 75%	T3 50%	T4 25%
Rice eel Meat (g)	73.04	54.78	36.52	18.26
Cornstarch (g)	0	18.26	36.52	54.78
Water added as ice (g)	20	20	20	20
Salt (g)	2	2	2	2
Garlic powder (g)	1.62	1.62	1.62	1.62
Guajillo chili powder (g)	1.62	1.62	1.62	1.62
Cumin (g)	0.43	0.43	0.43	0.43
Black Pepper (g)	0.43	0.43	0.43	0.43
Paprika (g)	0.86	0.86	0.86	0.86

**4. Processing of mexican-style chorizo sausage**

The samples of sausages were made using an ordinary technological procedure that consists of the following steps: preparation and weighing of raw materials, grinding, salting, mixing, pushing and cooking (Kašpar *et al.*, 2015).

The Rice eel meat was ground into a meat grinder with 6 mm diameter disk. After grinding, the meat was mixed with other ingredients before stuffing in a sausage casing tied by hand so that each sausage will be approximately 15 cm long or 6 inches (Raksakulthai *et al.*, 2004) [18]. The sausages were vacuum packed in sterile polyethylene bags. A total of 4 various batches was made. The samples were analyzed the day after production. For sensory analysis, the samples were

heated in boiling water for 2 min, cut into standard slices (1 cm), cooking at 70°C for 10 min based from Kašpar *et al.*, (2015).



**Fig 1:** Flow chart of making Mexican-style chorizo sausage using rice eel meat

**5. Sensory evaluation**

The sausages were sensory-evaluated by 50 semi-trained panelists who are all experienced in using sensory methods to assess the acceptability of the product. The attributes appearance, odor, flavor, and texture were evaluated using 9-point hedonic scale (1=“Dislike Extremely”, 5 =“Neither Like nor Dislike”, and 9=“Like Extremely; (Peryam & Pilgrim, 1957) [15]. Product was served cooked during sensory evaluation.

**6. Acceptability composite index**

Acceptability composite index is a procedure to follow and to determine the general acceptability of the product by ranking each treatment. The percentage in each criterion was computed through receiving the panels’ recommended allotted percentage. The ACI was the average percentage of each criterion among treatments. ACI procedure is based on (Reyes 2019) [20].

**7. Statistical analysis**

The weighted means of each treatment was calculated using SPSS Software. Statistical significance was determined by one-way analysis of variance (ANOVA) followed by a TUKEY test to compare the differences among treatments. Statistical significance was established at p<0.05. Descriptive analysis was also used using the Hedonic Scale.

**Results**

**1. Product acceptability and characteristics based on criteria of evaluation**

**2. Appearance**

In terms of appearance, MSC75 obtained the highest mean score of 7.58 followed by MSC50 with 7.34, MSC100 with 7.06 and MSC25 obtained the lowest score of 7.00. Based on the mean scores, MSC75 were described as “Like Very Much” LVM while all other treatments were described as “Like Moderately” LM. Statistical analysis showed no significance among treatments (Table 2).

**Table 2:** Appearance acceptability based on hedonic scale

Treatment	Description	Mean Hedonic Appearance
1	Control - Mexican-style Chorizo Sausage with 100% rice eel meat (MSC100)	7.06 <sup>a</sup> LM
2	Mexican-style Chorizo Sausage with 75% rice eel meat (MSC75)	7.58 <sup>a</sup> LVM
3	Mexican-style Chorizo Sausage with 50% rice eel meat (MSC50)	7.34 <sup>a</sup> LM
4	Mexican-style Chorizo Sausage with 25% rice eel meat (MSC25)	7.00 <sup>a</sup> LM

**Note:** Means within a column with different superscripts differ at p<0.05

**3. Odor**

With regards to odor, MSC25 obtained the highest mean score of 7.38, followed by MSC50 with an average score of 7.14 while MSC100 and MSC25 got the lowest score, which both have an average score of 7.02. All treatments were described as “Like Moderately” LM by the panelists. Statistical analysis showed no significance among treatments (Table 3).

**Table 3:** Odor acceptability based on hedonic scale

Treatment	Description	Mean Hedonic Odor
1	Control - Mexican-style Chorizo Sausage with 100% rice eel meat (MSC100)	7.02 <sup>a</sup> LM
2	Mexican-style Chorizo Sausage with 75% rice eel meat (MSC75)	7.02 <sup>a</sup> LM
3	Mexican-style Chorizo Sausage with 50% rice eel meat (MSC50)	7.14 <sup>a</sup> LM
4	Mexican-style Chorizo Sausage with 25% rice eel meat (MSC25)	7.38 <sup>a</sup> LM

**Note:** Means within a column with different superscripts differ at p<0.05

**4. Flavor**

For the attribute flavor, MSC75 obtained the highest mean score of 7.54 followed by MSC100, MSC50 and MSC25 with an average score of 6.86, 6.38 and 5.72 respectively. The panelists described the flavor of MSC75 as Like Very Much “LVM”, MSC100 as “Like Moderately” LM and MSC50 and MSC25 as “Like Slightly” LS. Statistical

analysis showed significant difference among treatments, MSC75 obtained significantly higher values compared to other treatments. On the other hand, it can be also observed that MSC50 is comparable to MSC100 and MSC25 in terms of flavor. This means MSC sausage with 75% rice eel meat received most favorable by the panelists.

**Table 4.** Flavor acceptability based on hedonic scale

Treatment	Description	Mean Hedonic Flavor
1	Control - Mexican-style Chorizo Sausage with 100% rice eel meat (MSC100)	6.86 <sup>b</sup> LM
2	Mexican-style Chorizo Sausage with 75% rice eel meat (MSC75)	7.54 <sup>a</sup> LVM
3	Mexican-style Chorizo Sausage with 50% rice eel meat (MSC50)	6.38 <sup>bc</sup> LS
4	Mexican-style Chorizo Sausage with 25% rice eel meat (MSC25)	5.72 <sup>c</sup> LS

**Note:** Means within a column with different superscripts differ at p<0.05

**5. Texture**

In terms of texture, MSC100 got the highest mean score of 8.02 while MSC25 got the lowest with 6.14 mean score, MSC75 and MSC50 obtained the mean score of 7.3 and 6.64 respectively. The texture of MSC100 was described by the panelists as “Like Very Much” LVM, MSC75 and MSC50 as “Like Moderately” LM and MSC25 was described as “Like Slightly” LS. Statistical analysis showed significant difference among treatments. Among the treatments, MSC100 is significantly higher than MSC75, MSC50, and MSC25. This means MSC sausage with 100% rice eel meat received the most favorable evaluation by the panelists in terms of texture. Moreover, there was no significant difference between MSC50 and MSC25.

**Table 5:** Texture acceptability based on hedonic scale

Treatment	Description	Mean Hedonic Texture
1	Control - Mexican-style Chorizo Sausage with 100% rice eel meat (MSC100)	8.02 <sup>a</sup> LVM
2	Mexican-style Chorizo Sausage with 75% rice eel meat (MSC75)	7.30 <sup>b</sup> LM
3	Mexican-style Chorizo Sausage with 50% rice eel meat (MSC50)	6.64 <sup>cd</sup> LM
4	Mexican-style Chorizo Sausage with 25% rice eel meat (MSC25)	6.14 <sup>d</sup> LS

**Note:** Means within a column with different superscripts differ at p<0.05

**6. Acceptability Composite Index**

The general acceptability of the product was determined using the acceptability composite index (ACI). The ACI is the average percentage in each criterion rated by the 50 random tasters. Based on the result, MSC75 ranked first with a total ACI of 7.30. MSC100 was determined as rank 2 with 7.22 ACI followed by MSC50 (6.90) and MSC25 (6.62) respectively.

**Table 6:** Acceptability composite index (ACI) for the general acceptability of the product

Treatment	Appearance 26.18%	Odor 28.32%	Flavor 23.14%	Texture 22.38%	Total ACI	Rank
1. MSC100	1.85 <sup>a</sup>	1.99 <sup>a</sup>	1.59 <sup>ab</sup>	1.79 <sup>a</sup>	7.22	2
2. MSC75	1.93 <sup>a</sup>	1.99 <sup>a</sup>	1.74 <sup>a</sup>	1.63 <sup>a</sup>	7.30	1
3. MSC50	1.92 <sup>a</sup>	2.02 <sup>b</sup>	1.48 <sup>b</sup>	1.49 <sup>b</sup>	6.90	3
4. MSC25	1.83 <sup>a</sup>	2.09 <sup>c</sup>	1.32 <sup>b</sup>	1.37 <sup>c</sup>	6.62	1

**Note:** Means within a column with different superscripts differ at  $p < 0.05$

T-test comparison between MSC75 and Pork chorizo is shown in Table 7. The result showed significant difference between the MSC75 and Pork chorizo in terms of odor, flavor and texture and no significant difference in the attribute appearance.

**Table 7:** T-test comparison between the T2 and Pork Chorizo

Group	Appearance	Odor	Flavor	Texture
T2 – MSC75	7.38 <sup>a</sup>	7.02 <sup>a</sup>	7.54 <sup>a</sup>	7.3 <sup>a</sup>
Pork chorizo	7.66 <sup>a</sup>	7.68 <sup>b</sup>	5.86 <sup>b</sup>	5.82 <sup>b</sup>

**Note:** Means within a column with different superscripts differ at  $p < 0.05$

**Discussion**

Rice eels usually have a dark body and head, with dark olive or brown dorsal coloring. When cooked it has fishy odor and taste, hence most consumers considered it as the least preferred fish commodity in the country. Therefore, ways to add value to rice eel, as a raw material in the production of ready-to-eat products, are of great interest, to offer value-added products and to address sustainability. In this study, four (4) different formulations were prepared using various proportions (100%, 75%, 50% and 25%) of rice eel meat. When developing products made from fish or products with a proportion of fish, it is important to take into account a level of suspicion among the population and to verify the potential consumer acceptability with the help of sensory evaluation of the final product (Kašpar *et al.*, 2015). Sensory evaluation is crucial as it ensures the acceptability, safety and quality of food products. By doing so, food manufacturers can develop products that meet consumer expectations, reduce waste and costs, and maintain a competitive advantage in the market.

In the case of experimental mexican-style chorizo sausages, there were no significant differences between the formulated sausages in the attributes appearance and odor. However, T2 (MSC75) stood out in the attribute appearance and T4 (MSC25) for the attribute odor based on the hedonic scores which both have a score of 7.38 and described as Liked Moderately. Following the method of Dutcosky (1996), the score of 7.38 is equivalent to 82% acceptability. Thus, it indicated that the appearance and odor of the MSC sausage were very well accepted by the panellists. According to Dutcosky (1996), values above 70% indicate the product’s acceptance.

On the other hand, there is a significant difference for the attributes flavor and texture. For the flavor, T2 (MSC75) received most favorable by the panelists rated Liked Very Much. For the attribute texture, T1 (MSC100) received most favorable by the panelists rated Liked Very Much. The concentration of the added cornstarch of the formulated sausages may have effect the texture in terms of hardness, T4 (MSC25) is the least preferred treatment containing highest cornstarch concentration described as Liked Slightly by the panelists. In the study conducted by Prabree and Pongsawatmanit 2011, the hardness values of fish sausages

increased significantly with increasing tapioca starch contents.

The general acceptability of the product was determined using the acceptability composite index (ACI). The ACI is the average percentage in each criterion rated by the 50 semi-trained tasters. The results of the sensory assessment showed that the number of scores attributed to the individual parameters were more on T2. It is evident in the parameters appearance and flavor. The Acceptability Composite Index (Table 8) confirms that treatment 2 is the most acceptable treatment among the group with the score of 7.3. The chorizo sausages are known for its red color prepared with various seasonings and spices giving it a red to orange color which is attractive to consumers. The addition of spices may have decreased the typical fishy taste of the rice eel. Further, the use of cornstarch as extender may have altered the quality of the fish chorizo sausage. Prabree and Pongsawatmanit (2011) reported that the use of tapioca starch can be used in the formulation for altering the quality of fish sausage. Starch is one of the food ingredients added into the raw batter mixture during formulation to improve the quality by acting as binder and as an agent for adhesion, gelling and moisture retention (Pietrasik, 1999; Aktas and Genccelep, 2006) [16]. The ACI also shows the percentage in each criterion which is 26.18% for appearance, 28.38% for odor, 23.14% for flavor and 22. % for texture.

Since T2 or mexican-style chorizo sausage with 75% rice eel meat is the most favorable treatment among the formulated sausages. T-test was also done to compare the treatment to commercial pork chorizo in the attributes appearance, odor, flavor and texture. Based from the result of the T-test (Table 7) the attributes appearance and odor of the pork chorizo is more accepted than MSC75, however the appearance has no significant difference between the two. As for the attributes flavor and texture MSC75 is more accepted than the pork chorizo. Spanish-style chorizo sausage was used to compare the best treatment of MSC sausage with rice eel meat. Spanish chorizos are dry-smoked sausages usually made from a mixture of minced pork and fat, with added salt, spices, Additives and has a hard, firm texture while Mexican chorizos are soft sausages (González-Tenorio *et al.*, 2013) [7]. Thus, soft sausage like Mexican-style chorizo sausage is more preferred than the hard and firm textured Spanish-style chorizo sausage.

**Conclusion**

The development of mexican-style chorizo sausage using rice eel meat is a good way to add value to this invasive fish species and this study showed that the developed product has a good sensory acceptability. The most acceptable treatment was MSC75 or chorizo sausage with 75% rice eel meat in the attributes appearance and flavor rated “Liked Very Much”. Further, it is also ranked first based on the ACI with the mean of 7.30. While MSC25 was the most favorable treatment for attribute odor and MSC100 for attribute texture.

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