International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Utilization and Acceptability of Noodles Enriched with Different Levels of Fish Protein from Bighead Carp (Aristichthys nobis)

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Abstract

Abundance and over supply of bighead carp (Aristichthys nobilis) in Laguna the Bay, the largest lake in the Philippines, which is sold almost three times lower in value than other freshwater fish such as milkfish and tilapia, has been one of the challenges encountered by fisher folks in the communities along Laguna de Bay. Utilizing post harvest bighead carp as fish protein source in food like in the production of noodle can serve as alternative means of using bighead carp flesh. The possibility of incorporating fish protein from bighead carp flesh in noodle production can help increase the economic value of bighead carp in the market. This can be an alternative source of income of fishermen apart from selling fresh bighead carp in the market. Determining the acceptability of noodles enriched with fish protein can help identify its feasibility in the market. With the use of sensory evaluation utilizing hedonic scale, findings revealed that of noodles enriched with different fish protein, the noodles with 25% fish protein is the most acceptable in appearance, aroma and palatability of noodle enriched with fish protein. Furthermore, the use of different amount of fish protein affects the texture and palatability of the noodles. The production of noodles enriched with fish protein from bighead carp can possibly be marketed since consumers noted that they prefer to eat noodles with more nutritional value and noodles enriched with fish protein taste the same with the commercial pasta.

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Keywords: Bighead carp; protein enriched noodles; hedonic scale; sensory evaluation.

1. Introduction

Fishing is the main source of living of the people along Laguna the Bay. In previous years, majority of the fish caught and produced along the bay are milkfish (Chanos chanos) and tilapia (Oreochromis niloticus) which are sold in bigger value but for almost a decade now, the dominant fish found in the lake are bighead carp (Aristichthys nobilis), sold three times lower than the value of milkfish and tilapia. In fact, bighead carp, locally known as "karpa" has displaced milkfish as the dominant fish species in Laguna de Bay. Over the past five years, Wilfredo G. Yap of the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC AQD) noted that carp production has increased considerably from 2,500 tons in 1997 to 18,945 tons in 2001. Milkfish production in fishpens, on the other hand, has shrunk from 15,325 tons in 1999 to 2,159 tons in 2001 [1]. Further report stated that overall, the production in fishpens and fishcages in Laguna de Bay had more than doubled during the 1996 to 2006 period. In 2006, milkfish contributed more to production but was closely followed by tilapia and carp. Total production of cultured fish was highest in 2005 and lowest in 1996. Production had been generally increasing over the 1996 to 2006 period except in 2001 and 2006 when production fell from previous year levels. Of the species, carp registered the highest average annual growth rate from 1996 to 2006 followed by milkfish and tilapia [2].

Increased production of bighead carp could have been good news but the bighead carp is not very popular as food due to lack of consumer acceptability [1]. The strong fish smell and the large bones of the bighead carp is one of the reasons why the there is low consumer acceptability of bighead carp. These make the market value of bighead carp low which amounts to 17.50 PHP per kilo as compared to the value of milkfish which amounts to 42.00 PHP per kilo [2].

To increase the market value of bighead carp, alternative use of bighead carp fish flesh must be utilized in such a way that consumers will not notice that the fish flesh comes from bighead carp. In this way, post harvest of bighead carp will increase in value and fisher folks will better income from bighead carp.

Utilization of bighead carp as fish protein source in the production of noodles is one of the ways on how bighead carp flesh can be consumed. Filipinos consume noodle as a source of carbohydrates. In fact, the study on the analysis of food consumption data in the Philippines for poverty estimation, the daily per capital food basket derived from all income group, noodles is on the top 7 with 8.1g daily consumption while in the bottom 30% income group, noodles is the 5th with 7.7g daily consumption [3]. Feasibility of the utilization of bighead carp as protein source in the production of noodles can be made possible if the acceptability of the noodles enriched with fish protein is determined.

2. Material and Methodology

2.1 Formulation of Noodles enriched with Fish Protein

Formulation of the noodles was conducted at the Fish Processing Center of the University of Rizal System,

Fisheries and Research Center, Cardona Rizal. The traditional recipes of noodles used by the researcher includes 300 g wheat flour, 3 pieces whole eggs and 1 table spoon of salt. To determine the effect of adding bighead fish protein in the characteristics of noodles, the total amount of wheat flour needed was altered with bighead fish protein. The formulation of noodles with 12.5% bighead fish protein contains 37.5 g bighead protein, 262.5 g wheat flour, 3 whole eggs and 1 tbs salt; 25% bighead fish protein contains 75 g bighead protein, 225 g wheat flour, 3 whole eggs and 1 tbs salt; 37.5% bighead fish protein contains 112.5 g bighead protein, 187.5 g wheat flour, 3 whole eggs and 1 tbs salt. The formulation used with 50% bighead fish protein contains 150 g bighead protein, 150 g wheat flour, 3 whole eggs and 1 tbs salt.

In making noodles enriched with fish protein, the bighead carp fish was scaled and cleaned. The fish was fillet and grinded using electric meat grinder. The ground fish was placed in a fine mesh drying tray and dried for two to three days under the sun. The dried surimi was grinded and pulverized using meat grinder. Pulverized surimi was blended with wheat flour and whole egg and mixed thoroughly. The mixture was formed in a ball, kneaded and cut using noodle machine. The noodles were sundried in two to three days. The noodles were blanched in boiling water for two minutes or until the noodles float. Noodles were rinsed, drained in colander for 30 minutes and served.

2.2 Sensory evaluation of noodles enriched with fish protein

The study used descriptive method of research. Sensory evaluation using of hedonic scale (1-9 scales) was utilizes to determine the acceptability of the appearances, texture, aroma and palatability of noodles enriched with fish protein. Twenty-five elementary teachers teaching Edukasyong Pantahanan at Pangkabuhayan (*EPP)* (Home and Livelihood Education) and twenty-five high school teachers teaching Technology and Livelihood Education from Bernardo F San Juan National High School, Looc Elementary School, M.C. San Juan Elementary School, Calahan Elementary School and Dalig Elementary School are the experts considered in the sensory evaluation.

The researcher used the sample stationary method. All samples with different level of fish protein content have coded digits. Teacher panelists were provided with sensory evaluation sheet using the 9-point hedonic scale with 1 extremely dislike and 9 extremely like.

The formulation with the highest acceptability is presented to students with age ranging from 12-16 years old and teacher with age range of 20-40 years old. They were chosen as respondents to determine the acceptability and marketability of the developed noodle enriched with fish protein. Ten-item validated questionnaire checklist was used to determine the marketability and acceptability of the developed noodles enriched with fish protein.

3. Literature and Study Review

3.1 History of Propagating carp in the Philippines

Chinese carps (bighead carp, Aristichthys nobilis) and silver carp, (Hypophthalmichthys molitrix) were

introduced in the Philippines in the late sixties. Due to limited knowledge on their seed production and the lack of private sector interest in their commercial culture, the full establishment of a major carp industry was not fully established. The propagation of Asiatic carps by hormone injection was first demonstrated in 1970 by fishery biologists of the Philippine Fisheries Commission (now Bureau of Fisheries and Aquatic Resources) and the Food and Agriculture Organization of the United Nations under the Freedom from Hunger Campaign working with two private hatcheries in Candaba, Pampanga and Dingle, Iloilo [4]. In 1983-1984 the Binangonan Freshwater Station (BFS) of SEAFDEC AQD concentrated its efforts in the artificial propagation of the bighead and silver carps, using the Chinese technique.

In the early 1970s, freshwater fish industry in Laguna de Bay, the country's largest freshwater lake, started through milkfish farming. Freshwater fish industry boomed through milkfish culture in fish pens and fish cages from early 1970's to the present. In recent years, popularity of milkfish culture is replaced by bighead carp production.

Common carp (Cyrpinus carpio) was introduced into the Philippines from Hong Kong in 1915. Other species of carps were later introduced. Their culture in fish pens and cages started in the second half of the 1980s [5]. The Philippine government has long tried to promote carp culture by establishing hatcheries in several regions. But they never became popular due to relatively low consumer acceptability. Many Filipinos do not find carp palatable, but bighead carp (Aristichthys nobilis) has recently become a dominant species in Laguna Lake fish pens [6].

As reported by Bureau of Agricultural Statistics in 2012, inland municipal fisheries showed improved performance in 2012 than in 2011 with Rizal and Laguna provinces in CALABARZON continued to be the top gainers and contributed 44.30% of the total production. Tilapia, milkfish (bangus), carp, freshwater catfish (hito), mudfish (dalag), gourami and freshwater goby (biya) were the common species caught by inland fishermen. Production of carp in 2012 was 17,703.89 metric tons. This was 2.09 percent more than the 2011 output. Rizal provinces where Laguna de Bay is found, is the top producing province, reported a 2.50 percent increment in production. There was good growth of carps in fish pens and fish cages in Rizal in 2012 and the biggest volume produced was on the fourth quarter when fingerlings stocked were of good quality and growth of stocks was enhanced by the abundance of natural food in Laguna Lake [7].

3.2 Carp Culture in Laguna de Bay

Fishpen and fishcage operations in Laguna de Bay are generally grow-out operations. Most fishpen operators grow only milkfish but others also raise in polyculture system tilapia and/or bighead carp. Bighead carp and tilapia are usually raised in a monoculture or polyculture system in fishcage operations. Occasionally, milkfish is raised in fishcages in polyculture with bighead carp and/or tilapia. Many fishpen and fishcage operations in Laguna de Bay use the extensive method of culture which depends only on the natural food in the lake for feeding the fish. The semi intensive or intensive method which uses supplemental feed in addition to natural food for the fish are utilized in other operations [8].

The few carp hatcheries around Laguna de Bay are sourced from bighead carp stocked in fishpen and fishcages of Laguna de Bay. At present, the municipality of Binangonan in Rizal where 9 bighead carp hatcheries operate is the main bighead carp fry and fingerling producer. In general, it takes about 3 days for bighead carp to grow from hatched egg to fry in the hatchery, 30 days for the fry to grow to fingerlings in the nursery and 4 to 6 months for the fingerlings to grow to marketable size in grow-out [2].

In terms of profit, it has been reported by the Survey of Fishpen and Fishcage and Operations in Laguna de Bay in 2007, that the price of bighead carp amounts to P17.50 per kilo, quite cheap as compared to the price of milkfish which amount to P42.00 per kilo. In a five hectare fishpen in Laguna de Bay the produced quantity of milkfish in kilogram in 33,333 that amounts to P1,400,000. 00 but the bighead carp produced in one hectare fishcage produces 9,000 kilogram [8].

By definition, a fishpen is an artificial and stationary water enclosure for the culture of fish and other aquatic animal species. It is made up of bamboo poles, wood, screen, and other construction materials intentionally arranged to prevent the escape of fish. A fishcage is an artificial and stationary or floating water enclosure smaller than a fishpen but made up of similar construction materials. In Laguna de Bay, a fishpen is further defined as having a water surface area of more than one hectare while a fishcage has a water surface area of one hectare or less. A fishcage in the lake generally has a net bottom while a fishpen has none. The production of milkfish may produce more profit but the capital used in raising milkfish is more expensive than in raising bighead carp.

3.3 Nutritional Content of carp

The nutritional content of a common carp fed with commercially available fishfeed for common carp has 5.55±0.102, g% Moisture, 45.52±0.045 g% Protein, 10.67±0.010 g% Fats, 5.68±0.070 g% Ash, 32.58 g% Total carbohydrates where total carbohydrates and other chemical compositions estimated by subtracting the mixture protein, fats and ash from the total weight. TBA index, mg MDA/kg is 2.81±0.004 and the Energy value, kcal/100 g is 343.89 where calories conversion factors used for proteins 4.3 kcal/g, for lipids 9.0 kcal/g, for carbohydrates 1.6 kcal/g [9]. Other studies showed different composition which showed that the protein contents of 29.5-33.8% and fat contents ranging from 9.1 to 19% [10]. Moreover others still stated compositions of proteins 23.85-24.84%, fats 6.85-13.01% and ash 12.98-13.38% [11].

There are also report in the pondental anatomy of common carp fish, 42.7% is the meat, 27.82% for the head, 11.65% viscera, 3.42% scales, 5.72% skin, 5.98% bones, 2.33% flippers and 0.31% blood. The composition of fish meat of common carp shows that it has Moisture, % 2.98±0.20; Protein, % 15.16±0.24; Fats, % 0.33±0.013; Ash, % 1.05±0.034 Glucieds, % ; pH 6.70; TBA index, mg MDA/kg 0.65±0.04 and Energy value, kcal/100g 70.41 [9].

3.4 Utilization of Fish Protein

The study on the nutritional, microbial and organoleptic qualities of fish patties prepared from common carp, findings revealed that patties prepared from the 501–750 g group of common carp, using boiled potato as the

extender were rated as the best. Furthermore, there were no significant difference (p>.05) on the appearance, color and taste of the fish patties prepared using different weight group of the fish or different extenders [12].

As revealed in the study of Sehgal (2008), these patties had slightly lower crude protein, total lipids and cooking yield, and slightly higher total soluble sugars than those prepared from rohu. Moisture content, fat retention capacity, and water holding capacity in the common carp and rohu patties were comparable [13].

The starches of potato having high amylopectin content gave cohesive gels as compared to cornstarch (having low amylopectin content), which increased rigidity and firmness of gels and thus gave better firmness/texture to the finished product [14,15]. The addition of cornmeal and soy protein in combination with sodium chloride improved texture of fish sausage [16]. An increase in the sensory score for crispness and adherence of batter of buffalo meat patties coated with batter mix prepared from corn flour (either alone or in combination with Bengal gram flour) [17]. Bengal gram flour with baking as processing treatment registered highest sensory scores [18].

On the physicochemical characteristics, sensory acceptability and microbial quality of Wadi Betok a traditional fermented fish from South Kalimantan, Indonesia revealed that the sensory evaluation showed that sample added with 15% salt had the highest score for texture: 5.90 ; aroma: 5.89 ; taste : 5.93 and color: 5.64. (1: extremely undesirable and 7 : extremely desirable) [19].

Corn snack fortified with 7% fish protein powder made from saithe (Pollachius Virens) surimi was selected by expert panel from industry for consumer studies in Iran and Iceland. They hedonically screened products with 3%, 5%, 7% and 9% fish protein powder. Snack containing 9% fish protein powder (FP) had significantly lower liking for odor, texture, flavor, and overall acceptability than the other three prototypes. Snacks fortified with 3%, 5%, and 7% FP had similar sensory attributes. Therefore, snack with the highest level of FP (7%) was selected for acceptance tests. It was seasoned with cheese powder, vegetable oil, salt, and colorant [20].

Calmorin in 2003 cited a study on milkfish bone meal as offal of boneless milkfish (Chanos chanos) Forssal utilized into embotido; its acceptability, salability and profitability. Organoleptic test with the use of 9-point Hedonic Scale were used fifty panelist to evaluate the quality attributes of the product. The results showed that the mean score for odor was 7.9, color 7.76, flavor 8.22, texture8.1, and general acceptability 8.0 all interpreted as like very much [21].

4. Results

Table 1 presents that mean and standard deviation as well as the frequency and percentage of the extremely liked or 9th scale of the sensory evaluation in terms of appearance, texture, aroma and palatability of the different concentrations of noodles enriched with fish protein from bighead carp.

As shown, noodles enriched with 25% fish protein and 75% noodle ingredients got the highest acceptability through sensory evaluation in terms of appearance, aroma and palatability with obtained mean of 8.34, 7.68 and 7.64, respectively. It also got the highest frequency of obtained 9th scale or with extremely liked appearance (60, 60%), aroma (10, 20%) and palatability (8, 16%). On the other hand, noodle enriched with 12.5% fish

protein got the highest sensory evaluation on texture with (mean of 8.34) and 9th scale response of 30 or 60%.

Table 1: Mean, Standard Deviation and Frequency and Percentage of Extremely Liked of the Sensory Evaluation of the Different Concentrations of Noodles Enriched with Fish Protein

	12.5% Fish protein			25% Fish Protein			37.5% Fish Protein			50% Fish Protein		
		9th scale			9th scale			9th scale			9th scale	
	Mean	F	%	Mean	F	%	mean	F	%	mean	F	%
Appearance	7.86	11	22	8.34	30	60	8.04	24	48	8.00	14	28
Texture	8.34	30	60	8.26	26	52	7.68	10	20	7.64	8	16
Aroma	7.42	6	12	7.68	10	20	7.44	6	12	7.46	7	14
Palatability	7.12	4	8	7.64	8	16	7.12	4	8	7.32	4	8

Table 2 depicts the ANOVA results of the significant difference between the appearance, texture, aroma and palatability of the noodle enriched with different concentrations of fish protein.

As presented, there is significant difference between the sensory evaluation of the noodles enriched 1.25%, 25%, 37.5% and 50% bighead carp fish protein in terms of its texture $F(3,196)=.000$, $p < .01$ and its palatability $F(2,196)=.023$ $p < .05$. On the other hand, there is no significant difference between the appearance $F(3,196) = .060$, $p > .05$ and aroma $F(3,196) = .491$, $p > .05$ of the noodles enriched with fish protein.

Table 2: ANOVA result of the Difference between the Sensory Evaluation of the different concentrations of noodles enriched with fish protein

		Sum of Squares	*Degrees of Freedom*	*Mean Square*	*F*	*p-value*
Appearance	Between Groups	6.120	3	2.040	2.512	.060
	Within Groups	159.160	196	.812		
	Total	165.280	199			
Texture	Between Groups	20.680	3	6.893	8.379	.000**
	Within Groups	161.240	196	.823		
	Total	181.920	199			
Aroma	Between Groups	2.200	3	.733	.808	.491
	Within Groups	177.800	196	.907		
	Total	180.000	199			
Palatability	Between groups	9.040	3	3.013	3.264	.023*
	Within Groups	180.960	196	.923		
	Total	190.00	199			

**The mean difference is significant at .01

*The mean difference is significant at .05

The table shows the t test results of the significant difference between the sensory evaluation of elementary and high school teachers teaching livelihood education on noodles with different amount of fish protein.

Findings depict that sets of respondents do not differ in their sensory evaluation on the appearance t(48,42)=.090 p > .05, texture t(48,45)=.148 p > .05, aroma t(48,39)=.766 p > .05and palatability t(48,40)=.626 p > .05 of the most acceptable noodles enriched with bighead fish protein or with 25% fish protein.

Sets of respondents have different sensory evaluation on aroma t(48,40)=.024 p < .05, and palatability t(48,43)=.000 p < .05 of noodles enriched with 12.5% fish protein, appearance, t(48,41)=.000 p < .05, aroma t(48,40)=.036 p < .05 and palatability t(48,43-)=.000 p < .05 of noodles enriched with 37.5% fish protein; appearance t(48,45-)=.013 p < .05 and palatability t(48,44-)=.001 p < .05 of noodles enriched with 50% fish protein.

Table 3: Significant Difference between the Sensory Evaluation of the Teacher Panelist on the Different Concentrations of Noodles Enriched with Fish Protein

	12.5% Fish Protein			25% Fish Protein			37.5% Fish Protein			50% Fish Protein	
	df	*t-value*	*p-value*	*df*	*t-value*	*p-value*	*Df*	*t-value*	*p-value*	*df*	*t-value*	*p-value*
Appearance	48 44	1.231	.224	48 42	1.730	.090	48 41	4.008	.000	48 45	2.599	.013
Texture	48 46	.153	.879	48 45	1.470	.148	48 35	.601	.551	48 40	.626	.534
Aroma	48 40	2.333	.024	48 39	.300	.766	48 40	2.158	.036	48 39	1.942	.058
Palatability	48 43	5.095	.000	48 40	.626	.534	48 43	.5095	.000	48 44	3.526	.001

Table 4 shows the total mean, standard deviation and t-test result of the acceptability and marketability of the noodles enriched with fish protein.

Table 4: Acceptability and Marketability of Noodles Enriched with Fish Protein as assessed by two groups of respondents

	Mean	sd	Verbal Interpretation	t-test p-value
Whenever I but processed food, I always consider the nutritional value of it. (Whenever my mom buy processed food, she always look at the nutritional content of it.)	4.28	.836	Strongly Agree	.537
I prefer to buy food enriched with nutrients. (My mom choose to buy food enriched with nutrients)	4.47	.751	Strongly Agree	.381
Food taste is secondary to me next to nutrition.	4.85	.363	Strongly Agree	.202
The fish protein enriched pasta has the same texture like the commercial pasta.	4.40	.795	Strongly Agree	.086
The fish protein enriched pasta looks the same as the commercial pasta.	4.37	.913	Strongly Agree	.731
The fish protein enriched pasta can be a substitute to the commercial pasta that I use/I eat.	3.71	.941	Agree	.064
I like the taste of the protein enriched pasta.	4.00	.967	Agree	.809
I prefer to eat fish protein enriched pasta more than the traditional commercial pasta because of its nutritional content.	3.97	.993	Agree	.249
I consider the good taste in a pasta.	3.92	1.003	Agree	.219
I will encourage my family to eat fish protein enriched pasta.	4.14	.950	Agree	.729

When the marketability of the noodles enriched with fish protein, the respondents are one in stating that they strongly agree that the nutrition is more important than the taste of food (mean=4.85, sd=.363), they consider the nutritional value in buying processed food (mean=4.28, sd=.836) and that they prefer to buy food enriched with nutrients (mean=4.47, sd=.751). Respondents agree that they prefer to eat fish protein enriched pasta more than the traditional commercial pasta because of its nutritional content (mean=3.97, sd=.993), the fish protein enriched pasta can be a substitute to the commercial pasta that I use and eat (mean=3.71, sd=.941), they consider the good taste in a pasta (mean=3.92, sd=1.003) and upon tasting the noodles/pasta enriched with fish protein, they will encourage their family to eat fish protein enriched pasta (mean=4.14, sd=.950).

In terms of the acceptability of the noodles enriched with fish protein, respondents strongly believe that fish protein enriched with pasta has the same texture as the commercial pasta (mean=4.40, sd=.795) and looks the same as the commercial pasta (mean=4.37, sd=.913). Respondents agree that they like the taste of the protein enriched pasta (mean=4.00, sd=.967).

Both respondents with age range of 12-16 and age range of 20-40, do not differ in their perception on the acceptability and marketability of noodles enriched with fish protein from bighead carp since the item's t-test p-values of .537, .381, .202, .086, .731, .064, .809, .249, .219 and .729, respectively are more than .05 ($p > .05$).

5. Discussion

Increased market value of bighead carp depends on the increased demand of the fish meat from this species. At present, fisher men are having a hard time selling the post harvest bighead carp in higher and more competitive value due to the consumer's low acceptability of the fish [2]. Utilizing bighead carp fish flesh as fish protein solution in food production can increase that market value of the bighead carp.

Utilization of bighead carp as protein source in noodle is most acceptable when 25% fish protein from bighead carp is incorporated in 75% wheat ingredient. The sensory evaluation revealed that this concentration have the most acceptable appearance, aroma and palatability of all the concentrations of noodles enriched with fish protein. High acceptability of noodles with this concentration could be due to the process of making the surimi which is incorporated in the noodles. Bighead carp have low acceptability since many consumers do not find carp palatable [6] probably due to its strong fishy smell. The process used by the researcher could have lessened the strong fishy smell that made it palatable for the consumers. It is further revealed that the evaluator have the same perception on the appearance, aroma, texture and palatability of the noodles with 25% fish protein. Findings further revealed that changing the concentration fish protein incorporated in the noodles changes that texture and palatability of the noodles. This could be since too much fish protein incorporated in the noodles changes the consistency of the noodles and makes it saggy that is why the texture is affected. The same way, incorporating too much fish protein creates strong fish flavor that makes the noodles less palatable. This means that the amount of binder and extender used in making noodles affect taste and texture of processed food incorporated with fish protein [12,14,15].

Findings further revealed that consumers aged 12-16 and 20-40 both strongly agree that the developed

noodles/pasta enriched with fish protein is comparable to the commercial pasta in terms of texture and appearance. The taste also appeals to the consumers. To add with, the developed noodles enriched with fish protein has good chances to be marketed since noodles consumers aged 12-16 and 20-40 give high regards to nutritional content of the food they eat. Furthermore, it is also noted that consumers prefer fish protein enriched noodles/pasta due to its nutritional content, thus they will encourage their family to eat fish protein enriched pasta.

The marketability of noodles enriched with fish protein can be attributed to the comparability of the developed noodles enriched with fish protein to the commercial noodles/pasta available in the market.

6. Conclusion

One way to help increase local fishermen's income along Laguna de Bay is by increasing the economic value of bighead carp fish. Fishes that have low consumer acceptability can be converted as fish protein source that can be utilized in the production of food. Utilizing bighead carp fish as source of fish protein in noodle making is one way on how to increase the acceptability of bighead carp. Considering the right amount protein fish that will promote the acceptability of bighead is a way on how to promote the marketability of noodles enriched with fish protein. The same way, the taste and consistency of noodles is affected by the amount of fish protein incorporated in the noodle ingredients. The marketability of noodles enriched with fish protein from bighead carp can help fishermen, their family and their community in finding alternative source of income from bighead carp fish. The local government through community cooperatives and community organizations can make use of the findings of the study as an alternative way on how to help fishermen community utilize bighead carp fish.

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