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"Yummy" Snakehead Sausage: Analysis of Nutrient Content and Acceptability of Fish Sausage in Lake Sentani Jayapura

Sri Iriyanti[1], Budi Kristanto[2], Nia Budhi Astuti[3]

[1,2,3] Department of Nutrition, Poltekkes Kemenkes Jayapura, Papua, Indonesia

Correspondence: Sri Iriyanti, Department of Nutrition, Poltekkes Kemenkes Jayapura, Papua, Indonesia Tel: +628529123683, E-mail: iriyantisri26@gmail.com

Abstract
Sausages are processed meals with two changes based on the composition and the formulation. The trend of consuming sausage increases annually both at national and international levels. The most common ingredients of sausages are beef and chicken. On the other hand, fish and snails could also become the ingredients as found in Japanese practices. This research determined the influence of the fish type on the nutrition contents, such as the water, ash, protein, fat, and carbohydrate; and the acceptability of fish sausage. The researchers carried out the research at the Food Laboratory of the Nutritional Department, the Integrated Laboratory of Polytechnic of Health Ministry of Jayapura, and the Mathematics and Science Laboratory of Universitas Cenderawasih. This complete random research design applied some factors to investigate, such as the formulation of the fish. The applied formulations were: F1 with 90% fish meat and 10% flour; F2 with 80% fish meat and 20% flour; and F3 with 70% fish meat and 30% flour. The researchers used some meats from Nile tilapia, snakehead, and flower horn cichlid fish. The researchers analyzed the nutrition content and found differences among the carbohydrate, water, and ash contents from all the fish. On the other hand, the protein and fat content of each fish were not significantly different. The organoleptic test found that the F3 category was the most preferable fish meat. The acceptability test found that 95.6% of respondents consumed all given samples. The researchers concluded that the fish sausage from snakehead fish, with a ratio of 70% fish meat and 30% flour, had the best organoleptic feature, excellent acceptability, and all the nutrition requirements suggested by Indonesia's National Standard of Fish Sausage.

Keywords: Fish Sausage, Nutrition Content, Organoleptic, Acceptability

1. Introduction

Sausages are processed meals with two changes: the composition and the formulation (Rosmawati et al., 2023). Sausage sales experience an increased trend annually (NasDaq, 2021; Pellegrini, 2022). The same trend is also observable in the United States of America (NHDSC, 2023; Statistika, 2023). The outcomes of sausage consumption in the United States of America reached 5.3 million dollars in 2022 (NHDSC, 2023). In Indonesia, the related data about consuming sausages are inaccessible. However, the researchers assume that sausage

consumption increases. PT. Charoen Pokphand Indonesia Tbk (CPI) also found increased sales from 2020 to 2022 with a percentage of 10.2% (PT. Charoen Pokphand Indonesia, 2023). CPI is the largest sausage manufacturer in Indonesia. The trend of consuming sausage increases because this food is familiar to all age communities (Nasdaq, 2021; NHDSC, 2023; Statistika, 2023).

Sausage ingredients are usually beef or chicken (Farida, 2018). However, some ingredients may be also from seafood and fish (Tanikawa, 1963; Chuapoehuk, Raksakulthai, & Worawattanamateekul, 2001; Oliveira et al, 2014; Kazemzadeh, 2022). Japanese people have been familiar with fish sausage for centuries. Tanikawa (1963) also explains that sausages in Japan are usually made from tuna, marlin, skipjack, bonito, salmon, and whale. The ingredients for producing sausages are developing (Sali & Rahmawati, 2023). This development includes the implementation of snakehead as the ingredient with frequent investigations. One of the investigations identifies the implementation of snakehead meat as the traditional and modern medication (Shafri & Manan, 2012). Therefore, snakehead sausage is more popular. Moreover, this ingredient also has high nutrition content (Lestari & Nanisa, 2014; Chaerunnimah et al, 2021). Studies also find snakehead meats have collagen as medication (Issains et al., 2019).

Many researchers studied snakeheads (Truc et al, 2017; Zakaria & Sarbon, 2018; Marlinda, 2020; Putri, 2022; Tawali et al, 2023). Many researchers used the snakehead as the ingredient to produce gelatin to preserve beef sausage (Tawali et al, 2023). Other studies cultivated snakehead as the ingredient to produce sausages (Truc et al, 2017). Some researchers also examined the organoleptic quality and protein levels of the pulps made from snakeheads (Marlinda, 2020). A study also examined the acceptability of the snakehead sausage with moringa leaf powder (Putri, 2022). Research also examined the benefits of snakeheads in preventing stunting (Chaerunnimah et al, 2021). Therefore, the researchers did not find any studies comparing the nutritional content and the acceptability of snakehead fish as the sausage ingredients. The researchers also did not find related research with fish from Sentani Lake in Jayapura.

The researchers analyzed the acceptability of Nile tilapia, snakehead, and flower horn cichlid fish. The researchers involved primary school learners as the respondents. The underlying reason is - primary school learners tend to consume sausages since sausages are a popular food among Indonesian learners (Arifin & Setyaningrum, 2022).

2. Research Methodology

This complete randomized research took three types of fish and three formulations. See Table 1 to understand the formulations.

Table 1: The Matrices and the codes of research treatments

The fish types	The first formula (F1) 10% flour: 90% fish meat	The second formula (F2) 20 % flour: 80% fish meant	The third formula (F3) 30 % flour: 70 % fish meat
Snakehead fish	GF1	GF2	GF3
Nile fish	NF1	NF2	NF3
Flowerhorn fish	LF1	LF2	LF3

The researchers conducted the research at the Food Laboratory of Nutritional Development at the Polytechnic of the Health Ministry of Jayapura to produce the sausages and promote the organoleptic test. On the other hand, the researchers conducted the chemical test, proximate, at the Mathematics and Science Laboratory of Universitas Cenderawasih. Then, the researchers conducted the acceptability test at Public Primary School 3 Abepura from May to October 2022.

The other applicable ingredients include Chicken eggs, cornstarch, sugar, garlic, pepper, cooking oil, water, ice, thread, and food-grade sausage plastic. Then, the researchers analyzed the nutrition content with H_2SO_4, Na_2SO_4,

Aquades, HCl, and Petroleum Ether. The sensory test or the hedonic test used: Sausage, drinking water, an organoleptic assessment form, and a comstock form.

The applied instruments to produce sausages included: a food scale, a container, a blender, a measuring cup, a stove, a pan, and a sausage maker. The sensory test instruments were: stationary and small plates. The analysis of the nutritional content used: A distiller+ an Erlenmeyer, a soxhlet, an oven, a furnace, a desiccator, a Waring blender, a volume pipet, and a scale + scaling bottle.

2.1. The Research Procedure

2.1.1. Producing the Fish Sausage

The researchers washed, filleted, and chopped the fish. Then, the researchers mixed the fish with salt and sugar. After that, the researchers stirred and left the mixture at a temperature between 3 and 4^{o}C for 48 hours. The researchers then put the chopped fish and flour based on the ratio. After that, the researchers put all the ingredients, seasoning, and ice cubes into the mixed fish and flour. Then, the researchers ground the ingredients with a blender or a chopper.

The researchers put the mixtures into the sausage plastics with a sausage maker. The length of the sausage was 10 cm for each sausage. Then, the researchers tied the tips of the sausages. Then, the researchers boiled the sausages at a temperature between 50 and 60^{o}C for 30 minutes. The researchers took out the boiled sausages and dipped them into ice liquid to cool the temperature down. Then, the researchers took the cooled sausages and the sausages were ready to serve.

2.2. The analysis procedure

2.2.1. The water content

The researchers took the samples for 2 grams to scale in a container. In this process, the researchers determined the weight of the bottle container so that the container weight was constant. Then, the researchers dried the ingredients inside the container in an oven at the temperature of 100^{o}C for 5 hours. After that, the researchers took the ingredients and cooled them inside a desiccator before scaling. The researchers heated the ingredients for 30 minutes and cooled them again before re-scaling the ingredients. The researchers repeated this treatment to reach the constant weight (the gap between the consecutive scaling process is 0.02 grams). Then, the researchers calculated the water content with the following equation.
(Normilawati et al, 2019):

$$\text{The water content} = \frac{\text{the initial weight - the final weight}}{\text{The initial weight}} \times 100$$

2.2.2. The ash content

The researchers measured the ingredients carefully for at least 20 grams within the dried porcelain with the given weight. The researchers lit the muffle to obtain the whitish ashes. Then, the researchers put the porcelain and the ashes into an exicator. After that, the researchers measured the weight of the ashes once they were cooled.

$$\text{The content of the ash} = \frac{A-B}{A}\ x\ 100$$

Remarks:

A. The initial weights of the porcelain and the ingredients
B. The final weights of the porcelain and the ingredients

2.2.3. Determining the Protein Content with the Kjedahl Method

The researchers applied these steps: measuring 0.51 grams of the sample to put into the 100ml kjeldhal flask; adding 2 grams of the selen mixture and 25 ml of thick H_2SO_4; heating or boiling up on electric heater to make the liquid clear and greenish (approximately 2 hours at the temperature of 420^{o}C); letting the liquid cool; diluting the liquid; and putting the liquid into a 100ml flask with a marked scale; adding 5 ml of the liquid and putting the liquid into a distillation; adding 5 ml NaoH 30%; adding some drops of PP indicator; distilling the liquid for 10 minutes; administering 10 ml boric acid 2% that previously mixed with the indicators; washing the tip of the coolant with the distilled water; and applying the HCL 0.01 N (4,5).

$$\% \text{ Protein} = \frac{(V1-V2) \text{ x N x } 0{,}014 \text{ x f.k x f.p}}{W}$$

Remarks:
W = the weight of the sample
V1 = the volume of HCL 0,01 N for sample penitentiary purposes
V2 = the volume of HCl for penitentiary purposes of the form
N = The normality of HCL
f.k = the common protein content of meals, 6.25
f.p = the distillation factor

2.2.4. The Fat Content Analysis with Soxhlet Method

The researchers grinded the samples, 2 grams. Then, the researchers put the samples into paper shells with the base covered by cotton. The researchers sealed the shells with cotton and dried them in an oven. The temperature was not higher than 80^{o}C for an hour. Then, the researchers put the samples into the soxhlet. In the previous step, the researchers put the dried-boiled stones into the fat flask. In this process, the researchers were aware of the stone weights. Then, the researchers extracted the fat with fat solvent or hexane for 6 hours. Then, the researchers distilled and dried the fat extract in a dryer oven at the temperature of 105^{o}C. Then, the researchers cooled the extract in an exicator for further scaling process. After that, the researchers re-conducted the process to reach the constant weight (6).

$$\% \text{ fat} = \frac{W - W1}{W2} \text{ x } 100$$

Remarks:
W = the weight of the sample (g)
W1 = the weight of the fat flask before the extraction (g)
W2 = the weight of the fat flask before the extraction (g)

2.2.5. The carbohydrate content (by the difference)

The researchers determined the carbohydrate contents with the by-difference method. This method calculates the contents of the water, ash, protein, and fat. Here is the equation to measure the carbohydrate content with the by-difference method (7).

The carbohydrate content (%) = 100% – (% water content + % ash content + % protein content + % fat content)

2.2.6. The organoleptic test

The researchers applied the organoleptic test with the hedonic method. This method measures the preferences toward the textures, tastes, colors, and smells of the fish sausages. Then, the researchers served the sausages to 25 respondents. Every respondent assessed the produced sausages twice at different times. Then, the researchers asked the respondents to assess by selecting specific criteria. Then, the respondents scored each criterion. Here is the

scale (8): Very like: score of 5; averagely like: score of 4; neutral: score of 3; dislike: score of 2; extremely dislike: score of 1

2.2.7. The acceptability

The researchers applied the Comstock test to examine the acceptability of 45 child respondents. The researchers served the fish sausage for the respondents to consume. If the respondents consumed all fish sausages, the researchers considered the respondents liked the fish sausages.

3. Results

3.1. The Nutrition Content of the Sausage

The nutrition of the sausages included protein, fat, water, and ash. The researchers analyzed the content proximately with the Indonesian National Standard Number 7755;2013. On the other hand, the researchers calculated the carbohydrate content with mathematics calculation by the difference. The researchers analyzed repeatedly, three times, for each sample. Table 2 shows the mean.

Table 2: The mean nutritional content of the fish sausage

Nutritional substances	Types of sausages									F	p-value
	Nile fish			Snakehead fish			Flowerhorn fish				
	F1	F2	F3	F1	F2	F3	F1	F2	F3		
Protein	13,66	11,98	8,12	16,12	14,75	11,25	10,29	8,54	6,34	3,926	0,081
Fat	5,44	4,32	3,53	6,56	5,46	5,01	4,26	4,05	3,68	4,167	0,073
Carbohydrate	9,59	13,67	19,39	5,31	9,83	15,35	20,66	23,17	26,27	7,245	0,025
Ash	1,07	0,94	0,89	0,78	0,63	0,57	1,12	1,11	1,04	19,845	0,002
Water	70,24	69,09	68,07	71,23	69,33	67,67	63,67	63,13	62,67	26,612	0,002

Source: the primary data

The researchers found the nutrition of the fish sausage. The highest one was the protein of the GF1 formula with a percentage of 16.12%. The same result was also observable in the fat content. The GF1 had the highest fat with a percentage of 6.56%. On the other hand, the highest carbohydrate was observable on LF3 with a percentage of 26.71%. The highest ash content was observable on NF1 with a percentage of 1.07%. The last one, the highest water content, was observable on GF1 with a percentage of 71.23%. The ANOVA analysis found the protein content of the fish sausage was 8.1%, while the fat was 7.3%. The result showed significant differences in each formula in terms of the carbohydrate content with a p-value of 0.025, the ash content with an ap-value of 0.002, and the water content with a p-value of 0.002. On the other hand, the researchers found no differences in terms of protein and fat content.

3.2. The organoleptic test

The researchers applied the hedonic test for the organoleptic test with a scale of 5. Then, the researchers determined the mean of the respondent acceptability with the scoring system. A score of 5 for the very like option, 4 scores for the 'like' option, a score of 3 for the 'average' option, a score of 2 for the 'dislike' option, and a score of 1 for 'the extremely disliked' option. The excellent acceptability of the respondents is represented by the high score. The researchers involved 25 respondents in this organoleptic test. All respondents were trained. Table 3 shows the results.

Table 3: The organoleptic mean score of the fish sausage

The feature of the organoleptic	Nile fish			Snakehead fish			Flowerhorn fish		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
Flavor	3,36	3,56	3,84	3,24	3,76	3,84	3,64	3,76	3,72
Color	3,6	3,96	3,52	4,04	3,84	3,56	2,3	2,8	3,44
Aroma	3,36	3,72	3,4	3,56	3,4	3,88	2,84	3,68	3,32
Textures	3,2	2,48	4,04	3,92	3,96	3,92	2,92	3,6	3,92

Sum	**13,52**	**14,72**	**14,8**	**14,76**	**14,96**	**15,2**	**11,72**	**13,84**	**14,4**
Mean	**2,38**	**3,68**	**3,7**	**3,69**	**3,74**	**3,8**	**2,93**	**2,46**	**2,6**

Source: the primary data

Table 3 shows that the flavor of the fish sausage, the Nf3, has the highest score with 3.84 (ranging from neutral or average until very like). The GF3, the snakehead fish with the third formulation, is the most preferable flavor with a score of 3.84 (neutral or average until very like). For the flower horn fish, the most preferable flavor is LF2 (neutral until very like option).

3.3. The best formulation and the advanced organoleptic test

The researchers had to calculate the mean scores of the three fish sausage types and the three formulas to determine the mean score of each fish sausage type. The researchers compared the highest mean scores with other fish sausage types to determine the highest acceptability. Here is the assessment.

The data analysis results of the organoleptic features of all fish sausages, starting from the Nile, snakehead, and flowerhorn types, showed that F3 was higher than F1 and F2. Thus, the researchers conducted the advanced organoleptic for F3. The test found the most preferable fish sausage. Table 4 shows the advanced test explanation.

Table 4: The organoleptic test mean of the fish sausage

The organoleptic feature	**Nile fish**	**Snakehead fish**	**Flowerhorn fish**
Color	3,44	3,48	3,44
Flavor	3,56	3,36	3
Aroma	3,48	3,52	2,72
Textures	3,32	3,72	3,2
Sum	**13,8**	**14,08**	**12,36**
Mean	**3,45**	**3,52**	**3,09**

Source: The primary data

The organoleptic of snakehead fish has the highest mean score (3.52) than the other types of fish sausages. Thus, the researchers examined the snakehead sausage to determine the acceptability of the respondents.

3.4. The Acceptability Test

The researchers examined the acceptability of the primary school learners as the respondents, 45 respondents. They were the fifth and the sixth graders. The researchers conducted the test at 10 in the morning in the classroom of the learners. The research site was at Public Primary School 3 Jayapura. The researchers examined the acceptability of the Comsok assessment form. Table 5 shows the acceptability of the sausage.

Table 5: The acceptability of the primary school learner respondents

Percentage (%) of the consumed samples	**N**	**%**
0 (not being consumed)	0	0
25 (being consumed for a fourth portion)	1	2,2
50 (being consumed for a half portion)	0	0
75 (being consumed for three-fourths portion)	1	2,2
100 (100% consumed)	43	95,6
Sum	**45**	**100**

Source: The primary data

Table 5 shows the test of acceptability. Most respondents, 43 respondents or 95.6% of primary school learners consumed all the given samples. On the other hand, only two respondents, 4.4%, did not consume the given samples.

4. Discussion

4.1. The nutritional content of the fish sausage

The researchers found the contents of protein, fat, and water in the GF1 were higher than the NF3 and LF3. The researchers also found the highest ash content in the first formula of the Nile fish, NF1. The results showed that snakehead fish was superior to Nile and flowerhorn fish as the ingredients to make sausages. The results also confirm the previous research's findings. Snakehead fish has a higher protein level than other freshwater fish (Truc et al, 2017; Marlinda, 2020; Chaerunnimah et al, 2021; Gobel et al, 2022).

On the other hand, the high meat content of fish also has high protein and fat content. On the other hand, high carbohydrate leads to low ash content. Zakarian & Sarbon (2018) also found that with every added content of 0 - 3%, of the snakehead fish, the protein of the sausage would increase by 18.83–19.59% while the fat with the increment between 7,91–9,07%. Zakaria & Sarbon (2018) explain that snakehead fish have the highest protein and fat content than Nile, flowercorn, and other freshwater fish.

The ANOVA results also showed the carbohydrate, water, and ash contents. Iqbal, Supriadi, and Nopianti (2015) also found that high ash content indicated the fish meat had mineral resources. Thus, the ash content could represent the total mineral of an ingredient Other minerals in an ingredient consists of two salt types: the organic and the inorganic salts. Most ingredients consist of 96% organic substances and water. The remaining percentage is full of mineral elements. High ash content indicates high inorganic materials in a product.

4.2. The organoleptic test

The organoleptic test found that snakehead fish was most dominant with a mean score of 3.74 on all formulations. This finding showed that snakehead fish was preferable by the respondents based on flavor, color, and aroma. however, the textures were still under average compared to Nile sausages. The results showed that the snakehead fish had better nutrition content, such as protein, fat, and water. The Fish could also become the potential alternative for children to improve their protein and fat so they could grow up better (Lestari & Nanisa, 2014; Truc et al, 2017; Zakaria, & Sarbon, 2018; Chaerunnimah et al, 2021; Gobel et al, 2022). Snakehead fish is also useful for medication because of its high collagen content (Shafri & Manan, 2012; Issains, et al, 2019). Snakehead fish is also useful as an additive ingredient to produce sausages with different main ingredients (Roemawati et al, 2023). Zakaria & Sarbon (2018) also found that the addition of hydrolyzate protein content from snakehead fish to produce sausages could improve the hardness, cohesiveness, and springiness of the sausages.

4.3. The Acceptability

Table 5 shows the acceptability results of the snakehead sausage. Most respondents, 43 (95.6%), consumed the given samples while only 2 respondents, 4.4%, did not. The findings showed that the respondents liked the sausages although the sausages were harder than Nile and Flowercorn fish. The result proved that the hardness was below the tolerance of the meal. Marlinda, Y. (2020) found that sausages from snakehead pulps also had excellent acceptability than other freshwater fish.

5. Conclusion

The snakehead fish sausage has excellent nutrition and is preferred by most primary school learners. The most preferable formula for the snakehead fish sausage is - 70% of snakehead fish meats and 30% flour. This formulation has the best organoleptic feature and acceptability. The results found a percentage of 95.7% of primary school learners consumed all given samples. The nutrition content of the sausage also met Indonesia's National Standard of Fish Sausage.

6. Suggestion

This research does not consider the influence of packaging on the storability of the product. The efforts of taking the benefits from sausages as healthy snacks for children could be an alternative to manage stunting problems and other nutritional problems of school-aged learners.

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References

Arifin, A., & Setyaningrum, D. (2022). Analisis pengaruh labelisasi halal, harga, promosi, cita rasa, dan citra merek terhadap keputusan pembelian sosis kanzler oleh generasi milenial (studi pada konsumen swalayan indomaret sragen) [Analysis of the influence of halal labeling, price, promotion, taste and brand image on purchasing decisions for Kanzler sausages by the millennial generation (study of Indomaret Sragen supermarket consumers)]. *Eqien - Jurnal Ekonomi Dan Bisnis*, *10(1), 428 - 437*. https://doi.org/10.34308/eqien.v10i1.557

Badan Standar Nasional Indonesia. SNI Sosis ikan [Indonesian National Standar of fish sausage]]Internet]. Jakarta: BSN; 2013. 11 p. Available from: https://kupdf.net/download/1434sni-7755-2013_59b69d3a08bbc5887e934730_pdf

Chaerunnimah, C., Amir, A., Lestari, R., & Adam, A. (2021). Analisis Zat Gizi dan Organoleptik Olahan Sosis Ikan Gabus sebagai Pangan Alternatif Mencegah Stunting [Nutritional and Organoleptic Analysis of Processed Snakehead Fish Sausage as an Alternative Food to Prevent Stunting]. *Jurnal Kesehatan Manarang, 7*(2). doi:10.33490/jkm.v7i2.552

Charoen Pokphand Indonesia (2023) Laporan Keuangan tahunan 2022 [2022 annual financial report]. Avaliable from: https://cp.co.id/wp-content/uploads/2023/05/Annual-Report-CPIN-2022.pdf

Gobel, C., Tahir, M., & Liputo, S. A. (2022). Karakteristik Fisikokimia Dan Organoleptik sosis Analog Berbasis Ikan Gabus (Channa striata) Dan Tepung Beras Ketan Hitam (Oryza Sativa Glutinosa)[Physicochemical and Organoleptic Characteristics of Analogous Sausages Based on Snakehead Fish (Channa striata) and Black Glutinous Rice Flour (Oryza Sativa Glutinosa)]. *Jambura Journal of Food Technology, 4(1), 22-33*.

Iqbal M, Supriadi A, Nopianti R (2015). Karakterisrik fisiko-kimia dan sensoris sosis ikan gabus dengan kombinasi jamur tiram (Pleorotus SP.). *FishrecH - J Teknol Has Perikan*. *4(2):170–8*.

Issains, F. B., Trinanda, A. F., Basyir, A. M., Benaya, A., Yuwono, A. H., & Ramahdita, G. (2019, December). Extraction of collagen Type-I from snakehead fish skin (Channa striata) and synthesis of biopolymer for wound dressing. *In AIP Conference Proceedings (Vol. 2193, No. 1)*. AIP Publishing.

Kazemzadeh, S., Abed-Elmdoust, A., Mirvaghefi, A., Hosseni, S., & Abdollahikhameneh, H. (2022). Physicochemical evaluations of chitosan/nisin nanocapsulation and its synergistic effects in quality preservation in tilapia fish sausage. *Journal of Food Processing and Preservation, 46(3), n/a*. https://doi.org/10.1111/jfpp.16355

Lestari, S. D., & Nanisa, S. K. (2014). Effects of different physical states of chitosan on the quality of chilled minced snakehead fish (Channa striata). *International Journal of Advances in Agricultural & Environmental Engineering, 1(1), 139-143*.

Marlinda, Y. (2020). Mutu Organoleptik dan Kadar Protein Sosis Ampas Ikan Gabus (Channa Striata) [Organoleptic Quality and Protein Content of Snakehead Fish (Channa Striata) Dregs Sausage].

Megan Pellegrini (2022). 2021 sausage report: ready to sizzle. Available from: https://www.provisioneronline.com/articles/111195-2021-sausage-report-ready-to-sizzle

National Hot Dog and Sausage Council (2023). In 2022 Americans spent more than $8,3 billion on hot dogs and sausages in US Supermarkets.

Normilawati, Fadlilaturrahmah, Hadi S, Normaidah (2019). Penetapan Kadar Air dan Kadar Abu pada Biskuit Yang Beredar Di Pasar Banjarbaru [Determination of water content and ash content in biscuits circulating in the Banjarbaru market]. *J Ilmu Farm [Internet]*. *10(2):51–5*. Available from: https://ejournal.stikesmukla.ac.id/index.php/cerata/article/view/77

Oliveira, A. C. M., Himelbloom, B. H., Montazeri, N., Davenport, M., Biceroglu, H., Brenner, K. A., Thomas, S. R., & Crapo, C. A. (2014). Development and characterization of fish sausages supplemented with salmon oil. *Journal of Food Processing and Preservation, 38(4), 1641-1652*. https://doi.org/10.1111/jfpp.12126

Pranisa Chuapoehuk , Nońgnuch Raksakulthai & Wanchai Worawattanamateekul (2001). Process development of fish sausage. *International Journal of Food Properties, 4:3, 523-529*, DOI: 10.1081/JFP-100108653

PUTRI, W. N. (2022). Daya terima sosis ikan gabus (Channa striata) dengan variasi penambahan tepung daun kelor (Moringa oleifera) [Acceptability of snakehead sausage (Channa striata) with variations in the addition of moringa leaf flour (Moringa oleifera).

Rosmawati, Abu, B. T., Muhammad, I. S., Sari, S. F., Lely, O. A., Iin, N. N., . . . Huda, N. (2023). Characteristics of the beef cheek meat-based sausage added with snakehead (channa striata) gelatin. *International Journal of Food Science,* doi:https://doi.org/10.1155/2023/6877904

Shafri, M., & Abdul Manan, M. J. (2012). Therapeutic potential of the haruan (Channa striatus): from food to medicinal uses. *Malaysian Journal of Nutrition, 18(1).*

Statistika (2023) US Population: Consumption of sausages from 2011 to 2024. Available from: https://www.statista.com/statistics/282454/us-households-consumption-of-sausages-trend/

Tanikawa, E. (1963). Fish sausage and ham industry in Japan. *Advances in food research, 12, 367-424*.

Truc, T. T. (2017). Improving the physicochemical properties of snakehead fish (channastriata) sausage by protease from its viscera. *Vietnam Journal of Science and Technology, 55(5A), 83*.

Zakaria, N. A., & Sarbon, N. M. (2018). Physicochemical properties and oxidative stability of fish emulsion sausage as influenced by snakehead (Channa striata) protein hydrolysate. *Lwt, 94, 13-19*. https://doi.org/10.1016/j.lwt.2018.04.026