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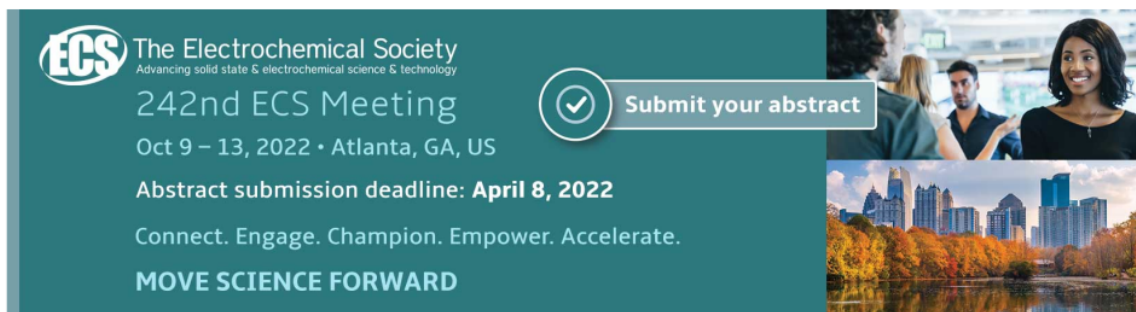
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Effect of cooking time on the quality of *nila nyat-nyat* (*Oreochromis niloticus*)

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Abstract. The right time for cooking *nila nyat-nyat* is very influential on subjective and objective value of *nila nyat-nyat*. The goal of this study was to determine the best time in cooking tilapia in order to get the best quality of *nila nyat-nyat*. The research was conducted at the Laboratory of the Faculty of Agriculture, Warmadewa University and the Faculty of Food Technology, Udayana University. This research used experimental method with completely randomized design of single factors with 6 different treatments and 4 replications. Quality assessment includes subjective tests through organoleptic analysis such as appearance, texture, odor, and taste, and also objective tests or nutritional analysis, such as water, fat, protein, and ash content. Statistical analysis with anova showed that the difference in cooking time gave significant influence in the organoleptic quality and nutritional value of tilapia (p value < 0.01). From this research, we conclude the best time for cooking tilapia was 30 minutes.

1. Introduction

Today's world population of more than 7 billion will rise to approximately 9 billion by 2030 and to 10 billion by 2050 [1]. With a growing world population, food security and availability have been a major society and international concern. Fishery resources are an important source of proteins, vitamins and micronutrients, particularly for many low-income populations in rural areas, and their sustainable use for future global food security has garnered significant public policy attention [2]. Fish protein represents an essential nutritional component in many countries. Fish provided more than 3.1 billion people with at least 20 % of their intake of animal protein [1]. FAO stated that the total fish supply will increase from 154 million tons in 2011 to 186 million tons in 2030 [3]. Aquaculture is an innovative strategy to promote sustainable availability of fish than captured fish in order to fulfil the increasing demand of fish each year.

Nile Tilapia (*Oreochromis niloticus*) are the most widely produced fish species around the world, with an annual production of 1,265,780 metric tons [4]. In Egypt, tilapia production has grown over the years and in 2010 reached 687,400 Mt valued at US\$991 which represents 38% of total fish value and 53% of total fish production [5]. Over many decades, tilapia has become one of the dominant species of fisheries sector in many Asian countries including China, Thailand, Vietnam, Indonesia, Malaysia, Phillipine and Sri Lanka due to its rapid growth rate, high market demand and increasing consumer acceptance [6]. As in Bali, the production of tilapia from aquaculture even reaches 1000 tons/year [7,8].



Balinese people are very fond of dishes derived from tilapia because of their thick meat and high nutritional content. Balinese people have been boiling tilapia on a frying pan with some Balinese spices until the water runs out. This Balinese food is already well known as *nila nyat-nyat* [7,9]. Basically fish is characterized by a desirable composition of amino acids, fish is also a rich source of vitamin, polyunsaturated fatty acids, and minerals that necessary for optimal health. Fish also generate scientific interest in the development and processing of high quality protein food to retain its aroma, appearance, and colour [8-10]. Some fish processing, such as boiling, smoking, or frying are believed to affect nutritional content and organoleptic quality of fish, including the *nila nyat-nyat* which is processed through boiling method in certain duration until the water runs out. Cooking time will greatly affect quality of the resulting tilapia product. This study was aimed to determine the effect of different boiling times on the quality of *nila nyat-nyat* in order to find the best duration in boiling tilapia. Through this research, we hope to find the best time in creating the best processed *nila nyat-nyat* as Balinese representative culinary.

2. Methods

This research was conducted around 1 month and took place in laboratory of Agriculture, Universitas Warmadewa and Universitas Udayana. The method used was an experimental based research with a completely randomized design, which consisted of treatment A (15 minutes cooking time), B (cooking time 20 minutes), C (cooking time 25 minutes), D (cooking time 30 minutes), E (cooking time 35 minutes) and F (40 minutes of cooking time). The six treatments tested in this study represented the facts or treatments that usually happened in the field. In order to get a valid data, repetition of each treatment was carried out 4 times.

The material used in this study was tilapias that are originating from Sangeh Fish Farm, Bali, which has been confirmed for its freshness and Balinese spices consisting of lemongrass, onions, bay leaves, pecans, galangal, salt, turmeric and ginger. The sample tilapias were rinsed and washed by water, then placed on a basin and covered with lime. The samples were left for 5 minutes, then fried half-cooked, and for the last, boiled together with herbs according to treatment (15 minutes (A), 20 minutes (B), 25 minutes (C), 30 minutes (D), 35 minutes (E), and 40 minutes (F)). Tilapia that has been cooked with several duration of time then had been distributed for analyses purpose. Subjective analysis, which was organoleptic test that included appearance, taste, texture, and odour, was carried out using organoleptic score sheet with 3 expert panellists [11].

Objective analysis consisted of water content, ash content, protein content, and lipid content. The method of determining the water content was carried out using the drying method. Samples as much as 3-5 gr were weighed and inserted into a dried cup and the weight were known. Then the sample and cup were dried in an oven at 105°C for 6 hours. The cup was cooled and weighed, then dried again until a constant weight were obtained. The method for measuring ash content was done by the direct method and using a muffle that temperature can be set. On this research, we used kjeldahl method to analyse protein levels and soxhlet method was used to measure fat or lipid content [12,13]. Data obtained from this study were analysed using ANOVA test with differences that were considered meaningful if P value was less than 0.05. If there were significant differences, analyses were continued with the Least Significant Difference (LSD) test.

3. Results and discussion

Objective assessment carried out in this research include water content, ash content, protein, and lipid content. It can be concluded that all parameters of water content, ash content, protein content, and fat content decreased along with treatment. The highest water content, ash content, protein content, and lipid content were in treatment A, while treatment F produced the lowest water content, ash content, protein content, and lipid content. Multivariate analyses with ANOVA showed significant differences among treatment for all parameters (p value <0.05). Different notations showed significant differences among treatment, as pointed in table 1.

Table 1. LSD test result among treatments.

Treatment	Water Content	Protein Content	Lipid Content	Ash Content
15 min (A)	70.63 ^a	20.62 ^a	6.88 ^a	1.80 ^a
20 min (B)	70.00 ^b	20.44 ^b	6.85 ^b	1.76 ^b
25 min (C)	69.11 ^c	19.88 ^c	5.67 ^c	1.49 ^c
30 min (D)	68.01 ^d	19.66 ^d	5.03 ^d	1.23 ^d
35 min (E)	67.00 ^e	18.95 ^e	4.18 ^e	1.16 ^e
40 min (F)	66.42 ^f	18.00 ^f	4.32 ^f	1.04 ^f

Subjective examinations carried out in this research included analysis of appearance, taste, odour, and texture which were assessed using an organoleptic scoring sheet. The best appearance was in treatment D with an average value of 7.80%, the best taste was also in treatment D, and treatment D got the best result for odour, whereas for texture, the highest value was obtained by treatment A. Multivariate analyses with ANOVA showed significant differences among treatment for all parameters (p value <0.05). Different notations showed significant differences among treatment, as pointed in table 2.

Table 2. LSD test result for organoleptic parameters.

Treatment	Appearance	Taste	Odour	Texture
15 min (A)	7,13 ^d	5,40 ^d	6,73 ^d	7,98 ^a
20 min (B)	7,35 ^c	5,73 ^c	7,22 ^c	7,80 ^b
25 min (C)	7,80 ^b	7,53 ^b	7,25 ^b	7,38 ^c
30 min (D)	7,87 ^a	7,70 ^a	7,60 ^a	6,87 ^d
35 min (E)	5,58 ^e	7,35 ^e	6,33 ^e	6,20 ^e
40 min (F)	5,38 ^f	5,33 ^f	6,25 ^f	5,50 ^f

Determination of protein, lipid, and mineral content of fish product is necessary to ensure that it meets requirements for food regulations and sometimes for commercial specifications. Some fish processing, such as boiling, frying, smoking, are known to affect quality of fish, and tilapia is not excluded as well [10,14]. This research basically was aimed to find the best boiling duration in order to produce high quality of tilapia products. The data generated from this study would also be very useful in providing information and guaranteeing the quality of *nila nyat-nyat* as a traditional Balinese cuisine.

This study found that the longer the boiling, the proximate value of tilapia products included ash, water, protein, and lipid decreased more. In fish processing methods like boiling which applies heat, time and temperature are the main factors which can affect protein quality, as time and temperature increases denaturation of proteins is affected in large amount as well as there is loss of vitamins, minerals, some other essential amino acids and other beneficial nutrients [14]. Water content is an important parameter in food spoilage since it will trigger the biochemical reactions. All the water content value in this research exceeded national standard of Indonesia year 2016 which stated the maximum value of water content should be 60%. From this point, boiling will cause protein degradation and the release of bonds between proteins and water molecules. Overheating can cause the tissues in the fish body to be unable to control the entry and exit of water. While the decrease in water content along with the boiling time was due to the boiling process that resulting in a decrease in water absorption [14,15]. Not only in protein and water content, fat content also decreased along with the duration of boiling. The decrease in fat content after cooking is caused by the nature of the fat that cannot stand over the heat, during the fish processing, the fat will melt and evaporate (volatile) into other components [16]. Ash content in tilapia clearly showed that there was an inorganic mineral content in the tilapia product. The decrease in ash content was caused by the reduction in minerals degraded by the influence of temperature and length of time of processing. This result was different from previous research which stated that the longer the boiling time the higher ash content of the product [17].

Sensory test or organoleptic assessment was conducted by well-trained panelist, included appearance, texture, taste, and odor. This assessment has significant contribution for product acceptability by consumer. Fish processing or cooking improves the color but also they have some impact towards texture and color during the process. Shrinkage of both filament lattice and collagen of proteins are resulted due to denaturation and aggregation during cooking, leads to loss in water holding capacity and consequently change texture of fish to became hard or firm. Heating affects the liquid holding capacity of fish, whereby resulted in protein deterioration. Overheating with higher temperature will lead to dehydration of the muscle through disruption of cell structures, resulting in very tough texture and difficult to eat [14]. Indonesia's national standard requires 7 as a minimum organoleptic value for processed fish products. In this study we found that treatments E and F did not meet Indonesian national standards. Boiling for too long would result in the appearance of tilapia products that were not intact, the taste was too salty, the smell was too pungent, and the texture was fragile. Otherwise, boiling in a short duration also would produce a bland taste and fishy smell due to the seasoning that has not been absorbed. In the end, thirty minutes was considered to be the best duration for processing tilapia.

4. Conclusion

This study concluded that boiling time affects the levels of protein, fat, water, ash and the organoleptic quality of processed tilapia products. According to the result, thirty (30) minutes is the duration of cooking that is considered appropriate to produce the best tilapia products in terms of biochemical compound and organoleptic. Further research related to the quality of microbiology and packaging of tilapia products is very necessary to be able to truly create the best processed Tilapia products.

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