Conference Paper

Characteristics and Shelf Life of Dry Salted and Unsalted Dark Banded Goatfish (*Upeneus sp.*)

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Abstract

Salted and unsalted dark banded goatfish (*Upeneus sp.*) has the physical and chemical characteristics which influence their shelf life. The objective of this research was to reveal chemical characteristic and the possibilities of physical differences between salted and unsalted dark banded goatfish and determine their shelf life. The experimental method that being used in this research was complemented with statistical analysis using paired difference test to know that salting significantly affected the chemical and physical characteristics of the products. Shelf life testing using total number of micro-organism as the parameter. Shelf life testing used descriptive and experimental methods followed by shelf life calculation using ASLT method with Arrhenius model. Result of the research revealed that there were significant differences between salted and unsalted dark banded goatfish in water level, ash content level, and water activity (a_w), but both of them had no significant differences in insoluble ash in acid level, protein level, fat level and hardness point. Salted dark-banded goatfish that packaged with PP 0,6 mm plastic at 15°C has the longest shelf life is about 15 months 27 days 3 hours 50 minutes and 24 seconds.

Keywords: salted dry; unsalted dry fish; characteristic; shelf-life.

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1. Introduction

Indonesia is a country with abundant marine prosperity. The marine resources can be utilized as a food source of Indonesian society. Dark banded goatfish or localy name is Kuniran fish, is one of the marine products which usually processed into salted and unsalted dried fish. In Indramayu District, this processing activities conducted by small scale industry (UKM), and one of the UKM is Berkah Mulya.

Dried fish is divided into 2 types, dried salted fish and dried unsalted fish. Dried salted fish processed through several processes, namely sorting, washing, draining, salting, drying, and packaging. Based on visual observations, unsalted dried fish have a harder texture when compared with salted fish. According to Desrosier [1], in the drying process, the air dissipates heat into the role of food in causing the water to evaporate and the food is released into the environment. The heating will cause denaturation

of the protein and reduce water holding capacity of meat. Meanwhile, fish drying process causes the hardening of protein denaturation and loss of fish because the water content so that the texture of the fish become brittle. This results in the handling of the dried fish such as packing and transportation should be carefully consider to avoid the product damaged and texture remain intact to consumers.

Therefore we need improved sanitation processing and packaging is also made of the products produced. Packaging that can be used is plastic PP (Polypropylene) and HDPE (High Density Polyethylene) because it is a package that is commonly used by SMEs. Additionally, the packaging of 0.6 mm PP and HDPE has a water vapour permeability that is low enough to pack the dried salted fish. PP packaging has a water vapour permeability of 680 ($cm^3/cm^2/mm/sec/cmHg$) × 1010 at 25 °C and 90% RH, while packaging HDPE has a water vapour permeability of 130 ($cm^3/cm^2/mm/sec/cmHg$) × 1010 at 25 °C and 90% RH [2]. In addition packaging purposes is to improve product quality also takes determination shelf life of salted and unsalted dried fish.

Safety zone of a food for consumers' product can be identified by determining the shelf life. Therefore, it takes some research to ensure food safety of salted and unsalted dried dark banded goatfish (*Upeneus sp.*) which processed in the Eretan village, Kandanghaur District, Indramayu district, West Java, namely the shelf life prediction. Estimation of shelf life of dried salted fish kuniran done with total parameter for total microorganism as a critical parameter. Deterioration salted and unsalted dried dark banded goatfish (*Upeneus sp.*) usually caused by microorganisms, especially fungi and bacteria halophilic. According to SNI No. 2721.1: 2009 on dried salted fish, Total Plate Count for dried salted fish products is a maximum 1,0 × 105 colonies/g.

2. Materials and Method

The main material used in this study was salted and unsalted dried dark banded goat fish (*Upeneus sp.*) from UKM Berkah Mulya in Eretan village, Kandanghaur subdistrict, Indramayu district, West Java. In addition, there were additional materials; distilled water, physiological saline, PCA (Plate Count Agar), alcohol 70%, HDPE, PP plastic 0.6 mm, 0.1 N NH_4CNS solution, and a solution of $AgNO_3$ 0,1N. HCL solution is 10%, ash-free filter paper, K_2SO_4, HgO, a solution of concentrated H_2SO_4, NaOH-$Na_2S_2O_3$ solution, distilled water, a solution of H_3BO_3, indicators mixture of methyl blue and methyl red, 0,02 N HCL solution, the solvent n-hexane, a solution of NaCl saturated, and other supporting materials.

The tools used in this research is analytical balance, oven, autoclave, water bath, incubator, colony counters, Aw meter, petri dishes, measuring cups, test tubes, erlenmeyer, aluminum bowls, and other support tools. Drying oven, desiccator, furnaces,

pumpkin kjeldahl, hot plate, distillation apparatus protein, fat pumpkin, Soxhlet extraction tool, Texture Analyzer TA-XT Express, aw meter AQUALAB type Lite, RH meter, and other support tools.

This research can be divided into two stages. Firstly is chemical and physical characterization and secondly is shelf life testing. In chemical and physical characterization, using experimental method with statistical analysis using the similarity test average two pairs. In shelf life testing, using ASLT Determination with Arrhenius Method using total count as a parameter of deterioration. The method used in this study is the experimental method with descriptive analysis (explanatory research).

Shelf life determination was conducted for salted dried dark banded goatfish (*Upeneus sp.*) using 3 types of packaging in 3 conditions of temperature of storage. The packaging which was evaluated respectively poly propylene plastic (PP), high density poly ethylene (HDPE) and without packaging in temperature of 15, 25 and 30 °C. Each day this product was evaluate in term of Total Plate Count of microbe and then compared with SNI Number: 2721.1: 2009 is a maximum of 1,0x105 colonies / g [3].

Calculation of the shelf life of salted and unsalted dried dark banded goatfish (*Upeneus sp.*) follow the Arrhenius equation:

$$K_T = A_0 e^{-Ea/RT} = A_0 e^{\left(-\frac{B}{T}\right)}$$

K_T = rate constant of a chemical reaction on the absolute temperature
A_0 = pre-exponential factor
Ea = activation energy,
R = universal gas constant

3. Results and Discussion

Result showed that there are differences between Salted and Unsalted Dark Banded Goatfish (*Upeneus sp.*) which produced by UKM Berkah Mulya. Each result was compared to SNI (national standard of Indonesia). Chemical Characteristics of Salted and Unsalted Dark Banded Goatfish (*Upeneus sp.*) was show in Table 1.

Similar Superscript code in horizontal, indicated not significantly different based on statistical analysis

Table 1 showed that each moisture content of processed fish meet the requirement of standard in Indonesia. Statistical analysis showed that the process of salting have a significant influence on the water content of salted dried dark banded goatfish. Salted dried fish has an average value of moisture content significantly higher than the unsalted dried fish. This is because the salting process occurs partly expenditure fluid from inside to outside the body of the fish that followed the entry of salt crystals

Table 1: Chemical Characteristics of Salted and Unsalted Dark Banded Goatfish (*Upeneus sp.*).

Parameter	Salted Fish	Unsalted Fish	Standar
Moisture (% wb)	33.168 [a]	15.075 [b]	Maks 40 *
Ash Content (% wb)	20.746[a]	14.343 [b]	16.5 **
Ash (insoluble in acid) (%)	0.526 [a]	2.250 [a]	Maks 0.3 *
Protein (%)	35.121 [a]	40,515[a]	42 **
Fat Content (%)	8.600 [a]	11.899 [b]	1.5 **
Note: * National Standard of Indonesia			
** Table Composition of Food Indonesia (TKPI).			

into the flesh of the fish. The liquid in the fish meat will then dilute the salt solution. The salt solution will seep into the flesh of the fish until the osmotic pressure balance is achieved between the fluid outside and in the flesh of fish [4].

The moisture contained in salted dried dark banded goatfish is higher than unsalted fish because of the residual fluid in the body of fish is bound by salt crystals through an ionic interaction. Ties and salt water is then lowered the amount of free water contained in fish meat so difficult to be removed during the drying process. In addition there are other factors that are believed to originate from the influence of the use of salt on fish protein. NaCl salt causes the electric charge of the protein bound by the ions Na + and Cl which further decrease the interactions between proteins, which encourages interaction between protein and water increased [5].

From the Table 1 and continue with statistical analysis showed significantly differences between the ash content of salted and unsalted dried dark banded goatfish. It is mostly caused by salted processing. According to SNI 01-2721-2009, dried salted fish products at least have a maximum salt content of 20%. The presence of the salt content would increase the mineral content contained in dried salted fish products, because salt is generally composed of 39.39% sodium (Na) and 60.69% of chlorine (Cl) and several types of other minerals such as magnesium (Mg) and calcium (Ca) [6].

Salt used for the manufacture of salted dried fish by SME in the village EretanKulon is not pure, but coarse salt. According to Reference [7], the purity of salt greatly affect the quality of salted fish. When the salt used is pure NaCl salt, salted fish will be creamy and soft. However, generally pure salt is rarely used, as well as on SMEs in the village Eretan Kulon.

Currently there is no standard limits of total ash in dried fish so that data of total ash content in salted and unsalted dried fish in Table 1 is compared with the total ash of salted dired fish in Table Composition of Food Indonesia (TKPI). The data in Table 1 shows that the average total ash content of salted dried dark banded goatfish was higher than that of TKPI, i.e. 16.5% [8]. Meanwhile, total ash content of unsalted dried

fish is lower than total ash content of dried salted fish products in TKPI. This is because the manufacturer did not put additional salt to unsalted dried fish as that in the process of salted dried fish.

Based on statistical analysis, there are no significant differences between both of processing methods. This is due to the variation of the test data insoluble ash in acid so that the statistical test showed salting process is done in the manufacture of salted dried dark banded goatfish not significantly affect ash content insoluble in both acidic samples.

Ash insoluble in acid shows and silica sand content in foodstuffs such. If the food contains a lot of ash insoluble in acid, it can be expected to contamination during processing of the material. Results of statistical tests that have been carried out on the samples showed that the salt used does not contain sand or silica so that the acid insoluble ash content of the two samples did not differ significantly although the average value is different.

When the data of salted and unsalted dried fish are compared with the limit for ash insoluble in acid SNI 01-2721-2009 about the quality requirements of dried salted fish, salted and unsalted dried fish have an average value of ash insoluble in acid that exceed the exposure limits, namely a maximum of 0.3%. This is thought to be due to contamination during washing process in unsalted dried fish. Salted and unsalted dried fish washing process carried out by SME owners using water from the coast, not with clean running water.

Dark banded goatfish processing methods which applied by SME owners in the village EretanKulon is not in accordance with SNI 03-2721-2009 about the handling and processing of dried salted fish. The S|NI Standard mention that the washing activity in processing of food should use cold water and drain. 5 °C temperature of the material to be preserved. Therefore improvements of washing technique hopefully will produce salted and unsalted dried fish which meets the standards.

Based on statistical analysis, there are no significant differences between both of processing methods related to protein content. This suggests that the process of salting does not affect the protein content of dried fish products significantly

Nowadays there is no standard that sets limits on the protein content of salted and unsalted dried dark banded goatfish products so that the data content of the protein products of salted and unsalted dried fish in Table 1 above is compared to the protein content of dried salted fish in Indonesian Food Composition Table (TKPI). The data in Table 1 shows that salted and unsalted dried fish has an average value lower protein content than the protein content anchovies are generally contained in TKPI, i.e. by 42% [8]. This is because the percentage of protein content contained in TKPI is a percentage of dried salted fish protein content in general. According Reference [9], the protein content of fish can be divided into high protein content (>20%), moderate protein

Table 2: Physical Characteristics of Salted and Unsalted Dark Banded Goatfish (*Upeneus sp.*).

Parameter	Salted Fish	Unsalted Fish
Hardness (gF)	1829.591 [a]	1412.375 [a]
Water Activity	0.742 [a]	0.814 [b]

content (15-20%), and low protein content (<15%). Protein contained in the fish meat fresh dark banded goatfish amounted to 15.43% [10] so that the dark banded goatfish belong to the fish with moderate protein content

Based on statistical analysis, there are significant differences between both of processing methods related to fat content. This is due to the influence of the water content of two samples. Fat content in salted dried dark banded goatfish was significantly higher than that of the unsalted ones. The fat content in the meat of fish is inversely proportional to its water content. The higher the water content in the body of the fish the lower the fat content in the body of the fish.

Currently there is no standard that establishes limits on the fat content of dried fish products so that the fat content of of both products of dark banded goatfish were compared to the levels of fat in dried salted fish products contained in TKPI, which amounted to 1.5% [8]. Based on the results of statistical tests, both products of dried dark banded goatfish have the average value of fat content (% wb) greater than the fat content dried salted fish products contained in TKPI. Salted dark banded goatfish an average value of 8.60% fat content while the unsalted dark banded goatfish have an average value of 11.89% fat content (% wb). This is because the fat content of the dark banded goatfish was quite high, namely 0.46% [10].

Physical characteristics of salted and unsalted dried dark banded goatfish is shown in Table 2. The table shows that salted dark banded goatfish has an average hardness value of 1829.591 grams of force, while unsalted dark banded goatfish have an average hardness value of 1412.375 grams force. According to Reference [8], the salt is a preservative is also added to the food because it can improve the consistency and stabilize the shape and form. Based on the results of statistical tests, the hardness of the two samples were not significantly different. This shows that the amount of salt used by SME is not contribute significantly to alter the texture of salted dark banded goatfish. The amount of salt used for the manufacture of the salted dark banded goatfish which is as much as 0.1 kg to 0.75 kg of salt/kg of fish.

Similar superscript code in horizontal, indicated no significant different based on statistical analysis

Another factor that is thought to cause the average hardness value salted dark banded goatfish was not significantly different with unsalted dark banded goatfish is the type of used salt. Salt used by SME is not pure salt, but coarse salt. According to Reference [7], the value of the texture of dried fish can be affected by the presence

of salt impurities. This salt impurities can cause fish meat becomes hard, brittle and stiff. This causes hardness value salted and unsalted dark banded goatfish was not significantly different salted dark banded goatfish moisture content significantly higher than unsalted dark banded goatfish.

Information about the value of hardness in the dried dark banded goatfish product is certainly usable for small business owners to determine the exact type of packaging to package the final product. According to Reference [11], the appropriate packaging is the packaging that can maintain the texture of the product longer and can slow down the damage caused by rancidity. Packaging that can be used to package fish drying result is plastic HDPE (high density poly ethylene) or PP (poly propylene) coated with aluminium foil as primary packaging. Primary packaging is placed in secondary packaging such as cardboard boxes, cans or rigid plastic containers. Ways to improve product durability against mechanical stresses one is by filling an inert gas such as nitrogen into the primary packaging

Based on statistical analysis, there are significant differences between both of processing methods related to water activity. This shows that the average value of water activity in dried dark banded goatfish products affected by salting process significantly. Data show that salted dried dark banded goatfish have a tendency to be more resistant to storage conditions because it has an average value of water activity lower than unsalteddried dark banded goatfish. According to Reference [4], microorganisms can easily grow on food that has a range of aw higher value.

The average value of water activity (a_w) salted dried dark banded goatfish is lower than the minimum value a_w suitable for bacterial growth halophilic, i.e. 0.75 [12]. The average value is also lower than the value aw salted fish produced in Indonesia in general, which ranged from 0.75 to 0.80 [3]. This is due to the use of salt in the manufacture of dried dark banded goatfish. According Reference [4], the salt can form ionic interactions with water on the food so that the water will be bound. Furthermore, the amount of free water available for the growth of microorganisms will be reduced thus lowering a_w value.

Unsalted dried dark banded goatfish have an average a_w of 0.814. A_w value is the value of water suitable for mold growth. A_w value of the minimum limit for mold growth itself is 0.80 [13]. A_w value of the two samples tested in this study is still large enough to categories of dried foodstuffs in general. According to Reference [4], foodstuffs which are dried at least have the a_w value below 0.65, the growth of microorganisms can be inhibited.

The presence of water activity value information of salted and unsalted dried dark banded goatfish can be used by small business owners to determine how the proper storage so that the dry product has a longer shelf life. According to Reference [13],

when the storage room temperature drying of fish products is set up around 0-5°C, then the shelf will reach six months.

3.1. Quantitative Analysis of Microorganisms

TPC (Total Plate Count) value in dried dark banded goatfish products is one of microbiological parameters to determine the level of deterioration of product quality and suitability for consumption. TPC test results showed that the dried salted dark banded goatfish TPC initial value of 2.7 × 102 CFU/g. The maximum value of TPC dried dark banded goatfish by 1x105 [3].

Based on the observations of the growth of microorganisms on salted dried dark banded goatfish products during the 6 days of storage, the results of quantitative analysis showed a close relationship between the storage times with the growth of microorganisms. The initial number of microorganisms (Ho) contained in salted dried dark banded goatfish that is equal to 2.7 × 102 CFU/g. The number of microorganisms on salted dried dark banded goatfish after storage for 1 day in treatment P25, H25, T25, P35, H35, and T35 increased. On the storage of 2 to 6 days all treatments salted dried dark banded goatfish, the number of microorganisms increases linearly. This was due to salted dried dark banded goatfish contain enough nutrients for the growth of microorganisms.

The microorganisms contained in foods can be derived from the raw materials used, production processes, equipment, or from the air or the surrounding environment. Microorganisms that can grow in salted dried dark banded goatfish are halophilic bacteria and mold because the product has a water content, a_w, and salinity accordingly.

3.2. Shelf life

All foods can be broken so that after some time of storage can be distinguished between the nutrient content of fresh foods with foods that have been stored. These changes can be interpreted as a deterioration of quality. The time period between fresh foods to be damaged and not suitable for consumption is called storability. Factors that cause deterioration of quality of foodstuffs, among others, changes in weather, mechanical damage, changes in water levels, the influence of oxygen, aroma is lost or contamination and microbial activity [2].

Determination of shelf life by Arrhenius model using an objective measurement data. Objective data derived from observations of the kinetics of quality changes. Data at the end of the observation that a limit on the number of microorganisms by SNI Number: 2721.1: 2009 on dried salted fish ie 1x105 colonies/g. Data kinetics of quality changes then plotted in the form of linear and exponential curve to determine the

Table 3: Shelf Life Dried Salted Dark Banded Goatfish at Different Temperature Storage with Different Types of Packaging.

Packaging Tipe	Storage Temperature (°C)	Storage Period (days)	Shelf Life
PP 0,6 mm	15	473.1600	15 months, 27 days
	25	65.9519	2 months 9 days
	30	25.7040	29 days
HDPE	15	352.0536	11 months, 26 days
	25	49.2465	1 months 23 days
	30	25.2110	29 days
Without Packaging	15	35.9107	39 days
	25	12.8856	16 days
	30	7.9177	11 days

order of the reaction force on the quality of the changes that occur. There are several stages to determine the shelf life of a food product, including the determination of the reaction order, the calculation of the value of Q10 (the rate of deterioration), Ea (Energy Activation), Ao (grades pre-exponential kinetic rate), and K (kinetic rate value).

3.3. Calculation Shelf Life

Calculation shelf life of dried salted fish in this study can be extended to a wide range of storage temperature in addition to the storage temperature at the time of the study. Calculation of shelf life at different storage temperatures were calculated using the Arrhenius equation with the following calculation:

$\ln C_t = K_T\ t + \ln C_0$	C_t = condition at the end of shelf life
$t = \frac{\ln C_t - \ln C_0}{K_T}$	C_0 = initial condition
	K_t = Rate kinetic on first order reaction
	t = Shelf life

Based on the calculation of the shelf life of dried salted dark banded goatfish at various storage temperatures can be seen that the higher the storage temperature, the lower of self life. This is because at higher the temperature, the microorganism growth rate will be higher. Temperature is a factor affecting food changes. The higher the storage temperature the reaction rates of various chemical compounds will increase [18]. Based on the above calculation, it can be seen that the dried salted dark banded goatfish without packaging has a shelf life shorter than the treatment of packaging with PP and HDPE. Dried salted dark banded goatfish treated with HDPE packaging has a shelf life shorter than the 0.6 mm PP packaging treatment. The sequence of

treatment research has the longest to the shortest shelf life is 0.6 mm PP packaging >HDPE> without packaging. It shows that if the products are packed with packaging that has a lower permeability will have a longer shelf life.

4. Conclusion

Dried salted and unsalted dark banded goatfish produced by Berkah Mulya SMEs in the village Eretan Kulon, Indramayu district have different chemical and physical characteristics in terms of moisture content, total ash, as well as the value of water activity (a_w) caused by the treatment of salting in the manufacture of salted dark banded goatfish. Both of these products have no significant differences in terms of ash content insoluble in acid, protein content, fat content, as well as the value of hardness (hardness).

Dried salted dark banded goatfish which packaged with 0.6 mm PP has the longer shelf life when store at 15 °C is about 15 months and 27 days, and at room temperature 25 °C ia about 2 month 9 days.

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