Conversion of fisheries processing by-product into salted-egg fish skin chips

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Abstract. Fisheries processing produces fish skin as a by-product. By using simple technology, the skin can be processed to produce high-protein snack foods, that the taste can be adjusted to the public tastes, such as chips. The economic value of these skin chips can be improved if they are packaged attractively and processed to a contemporary taste. The purpose of this study was to innovate technology in the utilization of fishery by-products to produce the salted egg fish skin chips and analyze its characteristics before and after storage. Fish skin used was tilapia fish (Oreochromis niloticus). The methods include the fish skin blanching using water at a temperature of 90°C for approximately 2 minutes, draining, and soaking in a 0.5% sodium bicarbonate solution at 21-23°C for 15 minutes, then salt 2% and garlic 2.5% (w/w) adding then deep frying with an oil temperature of 170-180°C for 75 seconds. Salted egg fish skin chips were packed in aluminum foil pouches and stored for 84 days. The parameters observed were yield, water content, ash content, protein content, fat content, and rancidity (TBA), physical tests (crispness, i.e., hardness and breaking force also aw), and microbiological analysis (total mold). The results showed that the yield of dried tilapia skin was 37.30%; water content increased during the storage and the same condition for ash content, protein content, fat content, and rancidity, but they did not change significantly. Likewise, crispness values were decreased, but aw values were increased during storage. While the total mold increased, but the value was still within safe limits. The salted egg chips from tilapia fish skin could still be developed to be accepted and safe for consumption by the consumers.

1. Introduction
The utilization of by-products from the fisheries product processing industry, such as fish skin, can be used as an alternative raw material for processed fishery products. The fish skin produced is 7-8% [1], and so far, it is still underutilized. If the fish skin is not processed further, it can cause environmental pollution because of the unpleasant smell [2]. The effort that can be done is to use the fish skin to become snacks such as chips. Chips can be made using simple and inexpensive technology that is tailored to the nutritional needs and pleasures of the community and can follow current trends.

Chips are snack foods that have high durability, delicious taste, and a lot of variety so that they can meet consumer tastes. Chips are processed food products that use raw materials directly without mixing...
with other ingredients. Chips are usually in the form of slices (the result of chopping raw materials) with the advantage that the original raw material taste can still be maintained and dominant [3]. The main characteristic of chips is that they have a crunchy texture. The quality requirements for chips are normal odor and color, distinctive taste, crispy texture, the maximum water content of 6% w/w, free fatty acids (calculated as uric acid) a maximum of 0.5% w/w, ash without salt is a maximum of 1% w/w [4]. This product has become popular and favored by the wider community and is consumed both as a snack and as a side dish [5]. In general, chips are made by washing, blanching, soaking in firming and developing agent, adding spices, drying, and frying [6]. This study was conducted as a development of previous research [7]. Tilapia skin chips were produced using salted egg powder flavoring to obtain skin chips that maintain their nutritional content but also meet current trends so that the consumer market is becoming more extensive. Tilapia skin was chosen as raw material for this research because of its high availability.

2. Materials and Methods

2.1. Materials
The raw material used was the skin of Tilapia (Oreochromis sp.), which was obtained from the by-product of the tilapia fillet processing industry in Semarang. Handling of the skin was done by cleaning the skin from the remaining meat and other impurities that were still attached and during the handling process. The skin temperature was kept cool. Other ingredients used were sodium bicarbonate, salt, refined garlic, and salted egg. The equipment used was a scale, stopwatch, thermometer, and drying tray. The analysis tools used were Texture Analyzer and a meter.

2.2. Methods
The research stages were as follows (Figure 1): cleaned fish skin was blanched at 90 °C for 15 minutes (mod [8]). Then the skin was drained and soaked in firming and developing agent, solution of 0.5% sodium bicarbonate (w/v) with a ratio of 1: 1 (w/v) at a temperature of 21-23 °C for 15 minutes (mod [9]) and added of 2% salt (w/w) and fine garlic 2.5% (w/w). Then the skin was dried in the sun until the moisture content reached 8%dw. The dried fish skin was fried using cooking oil at a temperature of 170-180 °C with a frying time of 75 seconds. The fried chips were added with salted egg powder flavor as much as 30% until evenly distributed to the entire surface of the fish skin chips. Subsequently, it was packed using an aluminum foil pouch and stored for 84 days. The water and ash content, as well as the TBA, were tested every 14 days.
Blanching at 90 °C, 15 minutes

Soaking the Tilapia skin in solution of 0.5% sodium bicarbonate (w/v), with ratio 1: 1 (w/v) at 21-23 °C, 15 minutes

Sun-drying Tilapia skin

Deep frying Tilapia skin

Mixing Tilapia Chips with salted egg flavor

Packing the fish skin chips with an aluminum foil pouch

**Figure 1.** The production stages of the salted egg fish skin chips.
The parameters measured were dried fish skin yield (based on the first and last weight), moisture content [10], ash content [10], protein content [10], fat content [10], changes of Thiobarbituric acid (TBA) value [11], physical tests (hardness and braking force using texture analyzer TA XT Plus and water activity (a_w) using a_w sprint TH-500 Novasina), and micro (total mold) [12].

3. Results and Discussion

3.1. Dried fish skin yield, moisture content, ash content, protein content, fat content, changes in the value of Thiobarbituric acid (TBA)

The yield of dried fish skin from this study reached 37.30%, while the water content, ash, protein, fat, and TBA values can be seen in Table 1. The water content of fish skin chips during 84 days of storage tended to increase from 4.44% to 5.73% but still met the requirements of SNI 01-4305-1996: a maximum of 6%. Changes in water content in the product are a very influential factor in reducing the quality of food products. The chips’ moisture content can affect the development process of chips at the frying stage, reduce the absorption of oil at the frying stage, produce a savory and crunchy taste when consumed after frying, and can last a long time [13]. Air frying also could be an alternative cause it developed a slower water evaporation rate and higher fish skin puffing ratio [14]. The water vapor permeability is an indicator of the packaging material's ability to withstand water vapor transmission rate at certain intervals. This is related to packaging applications; a good package has a small permeability value so as to reduce the rate of water vapor transmission from the environment into the packaged product [15].

| No | Sample | Water content (%) | Ash content (%) | Protein content (%) | Fat content (%) | TBA (mg malonaldehid/kg sample) |
|----|--------|------------------|----------------|-------------------|---------------|-------------------------------|
| 1  | H0     | 4.44             | 3.15           | 42.0              | 31.90         | 0.13                          |
| 2  | H14    | 2.98             | 3.55           | Not measured      | Not measured  | 0.16                          |
| 3  | H28    | 4.72             | 3.53           | Not measured      | Not measured  | 0.17                          |
| 4  | H42    | 5.37             | Not measured   | Not measured      | Not measured  | 0.18                          |
| 5  | H56    | 5.17             | Not measured   | Not measured      | Not measured  | 0.23                          |
| 6  | H70    | 5.71             | Not measured   | Not measured      | Not measured  | Not measured                  |
| 7  | H84    | 5.73             | 5.16           | 43.26             | 37.22         | Not measured                  |

Note: H0: storage day 0; H14: storage day 14; H56: storage day 56; H70: storage day 70; H84: storage day 84

The ash content of fish skin chips tended to increase. The ash content of fish skin chips did not meet the requirements of SNI 01-4305-1996, which is a max of 2.5%. The high ash content of chips was caused by the salt carried when the ash content was analyzing. Salt was added to the fish skin when producing chips and to the salted egg as a flavoring. The high ash content of chips also could be caused by the additional salted egg flavor and the presence of mineral components in the collagen that had not been released during the washing process. So the collagen was extracted and carried away during the ashes process [16].

The protein content of fish skin chips increased during 84 days of storage, but it was not significant. The increase in protein content is associated with an increase in the ash content of fish skin chips during storage. Elements in mineral components interact with foodstuff components to form protein complexes [17].

The fat content of fish skin chips also increased during storage for 84 days to 37.22%. The fat content in these skin chips is high due to the addition of salted egg powder to taste. Likewise, the TBA value tends to increase while the fish skin chips are stored. The longer storage time can cause fat damage resulting in a rancid smell and taste due to the oxidation reaction between the unsaturated fatty acids in
the product and the air in the package [18]. However, the TBA value still meets the requirements of SNI 01-2352-1991 [19] for food products, which does not exceed 3 mg malonaldehyde/ kg of sample.

3.2. Physical test (hardness and braking force as well as $a_w$)

Table 2 shows the results of the physical test as hardness and braking force as well as $a_w$. The hardness and braking force of the salted egg fish skin chips tend to decrease during 84 days of storage. The chips' texture is closely related to the crispness, and the chip's moisture content influences the level of crispness. The chips' lower moisture content of the chips fish skin salted egg was produced, and the chips will be crispier [20]. The high moisture content can also lead to product texture instability so that the material surface is conducive to growth and microbial damage [21]. And due to [22], crispness can be affected by the material nature and the structure that the material forms. The water activity ($a_w$) of the salted egg fish skin chips increased for 84 days of storage, about 0.507. This value is still in the safe range because, according to [23], the minimum requirements for viable microbes for bacteria are 0.9, yeast (0.80-0.90), and mold (0.60-0.70).

Table 2. Physical test (hardness and braking force as well as $a_w$) of the salted egg fish skin chips during the storage.

| No | Sample | Hardness (g force) | Breaking Force (mm distance) | $a_w$ |
|----|--------|--------------------|----------------------------|-------|
| 1  | H0     | 1800.23            | 145.83                     | 0.489 |
| 2  | H14    | 1565.96            | 146.34                     | 0.445 |
| 3  | H28    | 1481.06            | 144.00                     | 0.489 |
| 4  | H42    | 1561.92            | 74.03                      | 0.482 |
| 5  | H56    | 1560.36            | 73.10                      | 0.486 |
| 6  | H70    | 1513.30            | 74.39                      | 0.465 |
| 7  | H84    | 1617.91            | 71.86                      | 0.507 |

3.3. Microbiological analysis (total mold)

Microbiological analysis (total mold) of salted egg fish skin chips until 84 days of storage still meets SNI ISO 7932: 2012 [24]. The number of molds and yeasts allowed is a maximum of $1 \times 10^7$ colonies/ g of sample. The presence of mold is an indicator of deterioration of the product quality [25]. Microbiological quality or standards is a parameter that is not visible but very much determines the safety and durability of foodstuffs [26].

4. Conclusions

The research was carried out on utilizing fisheries processing by-products to produce the salted egg fish skin chips. Using an aluminum foil pouch, the chips were still acceptable for consumption after 84 days of storage. The yield of dried tilapia skin was 37.30%; water content had increased during storage days, also ash content, protein fat content, and rancidity did not change significantly. The crispness was decreased, but $a_w$ was increased during storage. While the total mold increased, it was still within safe limits.

References

[1] Murniyati, Dewi F R, Rosmawaty 2014 Teknik pengolahan tepung kalsium dari tulang ikan nila (Technique of processing calcium flour from Tilapia bones) Penebar Swadaya Jakarta P74 [In Indonesian]

[2] Kristianingrum S, Retno A S, Siti 2006 Pemanfaatan limbah kutil ikan menjadi kripik (rambak) (Utilization of fish skin waste into chips (rambak)) *Inotek: Jurnal Inovasi dan Aplikasi Teknologi* Universitas Negeri Yogyakarta Lembaga Pengabdian Kepada Masyarakat 10 (1) 13-25 [Online]
1. [BSN] Badan Standardisasi Nasional 1996 SNI Keripik singkong (SNI Cassava chips) SNI 01-4305-1996 Jakarta [In Indonesian]

2. Suryaningrum T D, Ikasari D, Supriyadi, Mulya I, Purnomo, A H 2016 Karakteristik keripik panggang ikan lele (Clarias gariepinus) dari beberapa perbandingan daging ikan dan tepung tapioka (Characteristics of grilled fish crackers from several ratios of catfish (Clarias gariepinus) meat and tapioca flour) Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan 11 (1) 25-40 [In Indonesian]

3. Sari R N, Suryaningrum T D 2019 Pembuatan keripik kulit dari hasil samping pengolahan ikan nila (Producing skin chips from the by-product of Tilapia processing). Prosiding Seminar Nasional Hasil Perikanan dan Kelautan XVI Yogyakarta 2019 16 342-346 [In Indonesian]

4. Gihinatya N 2002 Pemanfaatan kulit tuna mata besar (Thunnus obesus) sebagai bahan baku keripik kulit (Utilization of big eye tuna skin (Thunnus obesus) as raw material for skin chips) [Skripsi] Program Studi Hasil Perikanan Fakultas Perikanan dan Ilmu Kelautan Institut Pertanian Bogor [In Indonesian]

5. Kartika B, Hastuti P, Supartono W 1988 Pedoman uji inderawi bahan pangan (Guidelines for sensory testing of food ingredients) Pusat Antar Universitas Pangan dan Gizi Universitas Gadjah Mada Yogyakarta P116 [In Indonesian]

6. [BSN] Badan Standardisasi Nasional 2006 SNI Metode pengujian kimia produk perikanan (Chemical test methods on fishery products) SNI 01.2354-2006 Jakarta [In Indonesian]

7. Apriyantono A D, Fardiaz N L, Puspitasari, Sedamawati, Budiyanto, S 1989 Analisa Pangan (Food analysis) PAU Pangan dan Gizi IPB Press [In Indonesian]

8. [BSN] Badan Standardisasi Nasional 2006 SNI Metode uji mikrobiologi pada produk perikanan (SNI Microbiological test methods on fishery products) SNI 01.2332-2006 Jakarta [In Indonesian]

9. Santoso W 1997 Aneka pengolahan produk pertanian (Various of agricultural product processing) Instalasi Penelitian dan Pengkajian Teknologi Pertanian Jakarta [In Indonesian]

10. Fang M, Huang G J and Sung W C 2020 Mass transfer and texture characteristics of fish skin during deep-fat frying, electrostatic frying, air frying and vacuum frying LWT - Food Science and Technology https://doi.org/10.1016/j.lwt.2020.110494

11. Mukarromah R D 2014 Karaginan sebagai bahan dasar pembuatan film edible dengan tepung ubi jalar (Ipomoea batatas) (Carrageenan as the basic material for making edible films with sweet potato flour (Ipomoea batatas)) [Skripsi] Departemen Kimia Fakultas Matematika dan Ilmu Pengetahuan Alam Institut Pertanian Bogor [In Indonesian]

12. Astawan M, Aviana T 2002 Pengaruh jenis larutan perendam serta metode pengeringan terhadap sifat fisik, kimia dan fungisional gelatin dari kulit cucut (The effect of soaking solution type and the drying method on the physical, chemical and functional properties of gelatin from the shear skin). Seminar Nasional PATPI Malang 2002 [In Indonesian]

13. Verma D K V, Rivastav P P S 2017 Proximate composition, mineral content and fatty acids analyses of aromatic and non-aromatic Indian rice Rice Sci. 24 1 21–31
[18] Sammet K R, Duehlmeire R, Sallmann H P, Cantein C von, Mueffling T von, Nowak B 2006 Assessement of the antioxcidative potential of dietary supplementation with a tocopherol in low nitrite salami type sausages Meat Sci. 72 270-279

[19] [BSN] Badan Standarisasi Nasional 1991 Metode pengujian kimia produk perikanan penentuan angka asam thiobarbiturat (Chemical testing method for fishery products to determine the thiobarbituric acid number) SNI 2352:1991 Jakarta [In Indonesian]

[20] Wibowo 2006 Peningkatan kualitas keripik kentang varietas granola dengan pengolahan sederhana (Improved quality of granola potato chips with simple processing) Jurnal Akta Agronesia 9 2 102-109 [In Indonesian]

[21] Retnani Y, Suhail B, Lidy H 2009 Pengaruh jenis hijauan konsentrat dan lama penyimpanan terhadap sifat fisik wafer (The effect of concentrate forage type and storage time on the wafer physical properties) Jurnal Ilmiah Ilmu-Ilmu Peternakan XII 4 196-202 [In Indonesian]

[22] Neiva C R P, Thais Moron Machado T M, Tomita R Y, Furlani E F, Lemos Neto M J, Bastos D H M 2010 Fish crackers development from minced fish and starch: an innovative approach to a traditional product Ciênc. Tecnol. Aliment. Campinas 31 4 973-979

[23] Winarno F G 2007 Teknobiologi pangan (Food technobiology) M-Brio Press Bogor [In Indonesian]

[24] [BSN] Badan Standarisasi Nasional 2012 Mikrobiologi bahan pangan dan pakan - Metode horizontal untuk enumerasi Bacillus cereus terduga dst. (Food and feed microbiology - Horizontal method for enumerating suspected Bacillus cereus etc.) SNI ISO 7932:2012 Jakarta [In Indonesian]

[25] Sakti, H, Susi L, Agus S 2016 Perubahan mutu ikan gabus (Channa striata) asap selama penyimpanan (Changes in the quality of smoked snakehead fish (Channa striata) during storage) FishtecH – Jurnal Teknologi Hasil Perikanan 5 1 11-18 [In Indonesian]

[26] Jay J M, Loessner M J, Golden D A 2006 Modern Food Microbiology 7th edition Springer USA