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The Effect of Different Types of Packaging on the Quality of Instant Cendol Made from Snakehead Fish (Channa striata) Flour During Room Temperature Storage

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Kemasan, Cendol Instan, Aluminium Foil, Polypropylene (PP), Kemasan Kombinasi, Tepung Ikan Gabus.

ABSTRAK

Cendol adalah jenis minuman tradisional dengan tekstur lembut. Pembuatan cendol menggunakan beberapa jenis tepung atau pati, termasuk tepung tapioka, beras, dan tapioka. Selama ini, cendol basah memiliki kandungan air yang tinggi sehingga umur simpannya relatif pendek. Oleh karena itu, dilakukan inovasi dengan membuat cendol instan kering menggunakan tepung ikan gabus (Channa striata) yang terbuat dari daging ikan gabus dengan kandungan protein tinggi yang dapat meningkatkan nilai gizi dan memperpanjang umur simpan. Meskipun cendol instan dapat memperpanjang umur simpan, cendol instan membutuhkan kemasan yang bertujuan untuk memberikan perlindungan dari kerusakan fisik, gangguan hewan/serangga, dan keamanan kualitas agar tetap terjaga dan tersimpan dalam waktu lama. Tidak hanya itu, jenis kemasan yang digunakan sangat memengaruhi kualitas produk cendol instan selama penyimpanan suhu ruangan. Kemasan yang digunakan dalam penelitian ini adalah kemasan aluminium foil, kemasan polipropilen (PP), dan kemasan kombinasi yang memiliki karakteristik berbeda dalam melindungi produk dari faktor lingkungan. Metode penelitian ini dilakukan secara eksperimental dengan membuat cendol instan menggunakan tepung ikan gabus dengan pengaruh lama penyimpanan dalam kemasan yang berbeda. Desain eksperimental yang digunakan adalah Desain Acak Lengkap (CRD) Faktorial dengan 2 faktor: jenis kemasan yang berbeda dan umur simpan. Selama proses penyimpanan, dilakukan pengujian organoleptik, analisis kimia, dan penghitungan Ragi Jamur.

Keywords:
Packaging, Instant Cendol, Aluminum Foil, Polypropylene (PP), Combination Packaging, Snakehead Fish Meal.

ABSTRACT

Cendol is a type of traditional drink product with a soft texture, making cendol uses several types of flour or starch used including tapioca flour, rice, and tapioca. So far, making cendol in wet form has a high water content which causes a relatively short shelf life. Therefore, an innovation was made through making instant cendol in dry form with snakehead fish flour (Channa striata) made from snakehead fish meat with a high protein content that can increase nutritional value and extend shelf life. Although instant cendol can extend shelf life, instant cendol requires packaging that aims to provide protection from physical damage, animal/insect disturbances, and quality security so that it is maintained and stored for a long time. Not only that, the type of packaging used greatly affects the quality of instant cendol products during room temperature storage. The packaging used in this study is Aluminum foil packaging, Polypropylene (PP) packaging and combination packaging have different characteristics in protecting products from environmental factors. This research method was conducted experimentally by making instant cendol with snakehead fish flour with the influence of storage duration in different packaging. The experimental design used was a Completely Randomized Design (CRD) Factorial with 2 factors: different types of packaging and shelf life. During the storage process, organoleptic testing, chemical analysis, and Yeast Mold Count were carried out.

INTRODUCTION

Cendol is a traditional beverage product with a soft texture that is widely favored by various groups of people due to its distinctive and refreshing taste. Cendol is produced through the gelatinization process of starch. Currently, wet cendol has a very high water content reaching 89.47% (Wulandari et al., 2019), resulting in a relatively short shelf life. At room temperature, wet cendol can only last for about 6–12 hours, while under refrigerated storage it can last for 2–3 days (Anggraeni, 2002). This condition makes it difficult to store for a relatively long period. In addition, the nutritional content of cendol is still limited, mainly consisting of carbohydrates at around 12.85% (Fizriani et al., 2020). Therefore, to overcome these problems, an innovation is needed through the development of instant cendol in dried form using snakehead fish flour (*Channa striata*).

Snakehead fish flour is a processed product made from snakehead fish meat which is dominated by amino acids such as glutamic acid (1.45%) and leucine (0.54%), and also contains minerals dominated by iron (6.22%) and zinc (2.24%), which play important roles in the body's immune system (Dewita et al., 2022). Due to the nutritional composition of snakehead fish meat, particularly its protein and amino acid content, the product is susceptible to oxidation which may accelerate quality deterioration if it is not properly packaged.

Packaging is one method used to protect food products by enclosing them in a container or wrapper (Sari, 2021). In addition, packaging functions to protect products from physical damage, disturbances from animals or insects, and to maintain product quality and safety so that it can be stored for a longer period. The type of packaging used greatly influences the quality of instant cendol during storage at room temperature. Aluminum foil packaging, Polypropylene (PP) packaging, and combination packaging each have different characteristics in protecting products from environmental factors. According to (Jatiningrum et al., 2019), aluminum foil is widely used by household industries because it is hermetic, flexible, and impermeable to light. Therefore, it has the potential to maintain the quality of instant cendol.

Aluminum foil is a packaging material that is impermeable to water vapor and gases and resistant to external humidity, thereby protecting the physical and chemical quality of products. Aluminum foil packaging can maintain product shelf life for a considerable period. (Afdillah et al., 2018) reported that the use of aluminum foil packaging for tuna fish floss could extend shelf life up to 61 days at a temperature of 30°C. Polypropylene (PP) is also a suitable plastic material for food packaging. PP plastic is commonly used because of its characteristics, including a smooth surface, chemical resistance, high flexibility and durability, recyclability, and electrical insulation properties. In addition, the cost of PP plastic is relatively cheaper compared to other plastic raw materials (Deglas, 2023).

This study aims to determine the effect of different types of packaging during room temperature storage on the quality of instant cendol made from snakehead fish flour (*Channa striata*), as well as to determine the most effective packaging type in maintaining the quality of instant cendol during storage at room temperature.

The benefit of this study is to provide information regarding the effect of different packaging types during room temperature storage on instant cendol products made from snakehead fish flour (*Channa striata*), and to serve as a basis for selecting the appropriate packaging type for instant cendol products made from snakehead fish flour.

METHOD

This research will be conducted from June to September 2025. The study will take place at the Laboratory of Fishery Product Processing Technology, the Laboratory of Fishery Product Microbiology, and the Laboratory of Fishery Product Chemistry, Department of Fishery Product Technology, Faculty of Fisheries and Marine, Universitas Riau.

The materials used for making instant cendol in this study include snakehead fish which will be processed into fish flour, rice flour, tapioca flour, jelly powder (Nutrijel plain), pandan leaves (*Pandanus amaryllifolius*), water, aluminum foil plastic packaging, Polypropylene (PP) packaging, and combination packaging with a size of 10 cm × 17 cm. The chemical materials used for chemical and microbiological analysis include NaOH, HCl, bromcresol green, methyl red, distilled water (aquades), 70% alcohol, spiritus, and PDA (Potato Dextrose Agar).

The equipment used in the production of instant cendol includes a stove, oven, tray, weighing scale, basin, blender, and mold. The equipment used for chemical and microbiological analysis includes an analytical balance, beaker glass, oven, desiccator, metal spatula, test tubes, petri dishes, Erlenmeyer flask, incubator, beaker tongs, hot plate, dropper pipette, Bunsen burner, inoculating loop, and hot plate.

This study was conducted experimentally by producing instant cendol made from snakehead fish flour and evaluating the effect of storage duration in different types of packaging. The experimental design used was a factorial Completely Randomized Design (CRD) with two factors: the type of packaging, namely aluminum foil packaging, Polypropylene (PP) packaging, and combination packaging (aluminum foil and PP), and storage duration at room temperature, namely 0, 10, 20, and 30 days.

The procedure for producing snakehead fish flour begins with preparation to separate fish meat from bones, scales, fins, head, and viscera. The fish meat is weighed and then subjected to a steaming process by heating water to a temperature of 100°C for 10 minutes. The steaming process is used because it can produce higher albumin content compared to the boiling technique. After steaming, the fish meat is dried using an oven for 24 hours at a temperature of 45°C. The dried fish meat is then ground and sieved using a 100-mesh sieve to obtain fish flour.

Next is the process of making instant cendol. The cendol dough is prepared using 40 g of tapioca flour, 60 g of rice flour, and 5 g of snakehead fish flour. Pandan leaves (25 leaves) are used to produce pandan leaf extract, and 400 ml of the extract is added along with other ingredients. The mixture is stirred slowly until evenly mixed. The cendol dough is then cooked in water at a temperature of 100°C until it forms a gel for 15 minutes. After that, the dough is molded using a cendol mold with a size of 0.5 cm. The molded cendol is then cooled at room temperature and dried in an oven at 50°C for 12 hours.

The dried cendol produced is then packaged using three types of packaging: aluminum foil packaging, Polypropylene (PP) packaging, and combination packaging. After packaging, the products are stored at room temperature for 0, 10, 20, and 30 days. During the storage process, organoleptic tests, proximate analysis, and yeast and mold count analysis are conducted.

RESULTS AND DISCUSSION

Organoleptic Assessment

1. Appearance Value

   Appearance is one of the important organoleptic parameters because it is the first factor observed by consumers when evaluating a product. The results of the quality test for the appearance of instant cendol made from snakehead fish flour using different packaging types during room temperature storage can be seen in Table 1.

Table 1. Appearance value of instant cendol with snakehead fish flour in different packaging during storage at room temperature

Treatment	Day/Group				Average
	0	10	20	30	
P_1	8.49g	8.28fg	7.92e	7.33c	8.01 ± 0.51c
P_2	8.23f	8.00ef	7.08b	6.82a	7.53 ± 0.69a
P_3	8.41g	8.13f	7.64d	7.10b	7.82 ± 0.57b
Average	8.37 ± 0.13d	8.14 ± 0.14c	7.55 ± 0.43b	7.09 ± 0.26a	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 1, the appearance score of instant cendol made from snakehead fish flour decreased during storage from day 0 to day 30. The appearance score for instant cendol in P1 packaging was 8.01, with the criteria of intact, clean, neat, and bright green color. Meanwhile, the appearance score for P2 packaging was 7.53, with criteria of intact, clean, neat, but with a less bright green color. The appearance score for P3 packaging was 7.82, with criteria of intact, clean, neat, and bright green color.

The results of the analysis of variance (ANOVA) showed that the appearance score of instant cendol made from snakehead fish flour was highly significantly affected by differences in packaging types, where the calculated F value (160.68) was greater than the F table value at the 5% significance level (3.40). At a confidence level of 95%, H_0 was rejected, and the Honest Significant Difference (HSD) test was conducted. The ANOVA results also showed that storage duration had a very significant effect on the appearance score. The appearance score of instant cendol at storage time H0 was 8.37, at H10 was 8.14, at H20 was 7.55, and at H30 was 7.09, where the calculated F value (714.64) was greater than the F table value (3.01) at the 95% confidence level. Therefore, H_0 was rejected and followed by the Honest Significant Difference (HSD) test.

The interaction between packaging type and storage duration for instant cendol made from snakehead fish flour, based on the ANOVA results, showed a significant effect on the appearance score. The highest appearance score was obtained from P1 packaging at storage time H0 with a value of 8.49, while the lowest appearance score was obtained from P2 packaging at storage time H30 with a value of 6.82. The calculated F value (14.19) was greater than the F table value (2.51) at a 95% confidence level, therefore H_0 was rejected and followed by the Honest Significant Difference (HSD) test.

The differences in appearance scores among different packaging types were caused by variations in the ability of each packaging material to resist light exposure. Packaging with high light transmission allows more light to enter and affects the visual appearance of the product (Johnrencius et al., 2017). (Dewi et al., 2022) reported that the lowest average appearance preference score was obtained from polypropylene packaging, while the highest score was obtained from aluminum foil packaging. Aluminum foil packaging has better resistance to light compared to polypropylene packaging, which is transparent and therefore has lower resistance to light exposure.

2. Aroma Value

The results of the aroma quality test of instant cendol made from snakehead fish flour with different packaging during storage at room temperature can be seen in full in Table 2.

Table 2. Aroma value of instant cendol made from snakehead fish flour in different packaging during storage at room temperature.

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	
P_1	$8{,}52^{f}$	$8{,}23^{e}$	$8{,}04^{e}$	$7{,}64^{d}$	$8{,}11\pm0{,}37^{c}$
P_2	$8{,}09^{e}$	$7{,}45^{cd}$	$6{,}95^{b}$	$6{,}48^{a}$	$7{,}24\pm0{,}69^{a}$
P_3	$8{,}25^{e}$	$7{,}75^{d}$	$7{,}57^{d}$	$7{,}24^{c}$	$7{,}70\pm0{,}42^{b}$
Average	$8{,}29\pm0{,}22^{d}$	$7{,}81\pm0{,}39^{c}$	$7{,}52\pm0{,}55^{b}$	$7{,}12\pm0{,}59^{a}$	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 2, the aroma value of instant cendol made from snakehead fish flour for P1 packaging was 8.11, categorized as very fragrant with a typical pandan aroma of cendol. Meanwhile, the aroma value of instant cendol made from snakehead fish flour for P2 packaging was 7.53, categorized as fragrant with pandan leaf aroma, and the aroma value for P3 packaging was 7.82, categorized as very fragrant with a typical pandan aroma of cendol.

The analysis of variance (ANOVA) results showed that the aroma value of instant cendol made from snakehead fish flour was significantly affected by the differences in packaging types, where the Fcount value (273.82) > Ftable 5% (3.40) at a 95% confidence level, therefore H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The ANOVA analysis also indicated that the aroma value of instant cendol made from snakehead fish flour was significantly affected by storage time. The aroma value at H0 storage time was 8.29, then decreased to 7.81 at H10, 7.52 at H20, and 7.12 at H30. Since Fcount (266.51) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and further analysis using the Honestly Significant Difference (HSD) test was conducted.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour, based on the ANOVA results in Appendix 3, showed a significant effect on aroma values. The highest aroma value was obtained in treatment P1 with storage time H0 (8.52), while the lowest aroma value was obtained in treatment P2 with storage time H30 (6.48). Since Fcount (12.31) > Ftable (2.51) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The high organoleptic value observed in the aluminum foil packaging treatment is due to its low permeability to oxygen and water vapor (Undurraga et al., 2007). The ability of aluminum foil packaging to maintain aroma was also reported by (Tokiman et al., 2019), who stated that products packaged in aluminum foil experienced no significant decrease in organoleptic aroma values compared to other types of packaging. The ability of packaging materials to maintain low peroxide values is directly related to the aroma organoleptic properties perceived by panelists. This factor is associated with odor-active compounds formed from the increase in peroxide values in stored products (Xu et al., 2021).

3. Texture Value

The results of the texture quality test on instant cendol made from snakehead fish flour in different packaging during storage at room temperature can be seen in full in Table 3.

Table 3. Aroma value of instant cendol made from snakehead fish flour in different packaging during storage at room temperature.

Treatment (Packaging)	Day				Average
	D_0	**D_{10}**	**D_{20}**	**D_{30}**	
P_1	$8{,}46^{h}$	$8{,}26^{g}$	$7{,}80^{ef}$	$7{,}51^{cd}$	$8{,}01 \pm 0{,}43^{c}$
P_2	$8{,}08^{fg}$	$7{,}74^{e}$	$6{,}90^{b}$	$6{,}32^{a}$	$7{,}26 \pm 0{,}80^{a}$
P_3	$8{,}13^{g}$	$7{,}92^{f}$	$7{,}56^{d}$	$7{,}36^{c}$	$7{,}74 \pm 0{,}35^{b}$
Average	$8{,}22 \pm 0{,}21^{d}$	$7{,}97 \pm 0{,}26^{c}$	$7{,}42 \pm 0{,}47^{b}$	$7{,}06 \pm 0{,}65^{a}$	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 3, the texture value of instant cendol made from snakehead fish flour for P1 packaging was 8.01, categorized as very dry and compact. Meanwhile, the texture value of instant cendol made from snakehead fish flour for P2 packaging was 7.53, categorized as dry and compact, and the texture value for P3 packaging was 7.82, also categorized as dry and compact.

The analysis of variance (ANOVA) results showed that the texture value of instant cendol made from snakehead fish flour was significantly affected by the differences in packaging types, where the Fcount value (396.12) > Ftable 5% (3.40) at a 95% confidence level. Therefore, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The ANOVA analysis also indicated that the texture value of instant cendol made from snakehead fish flour was significantly affected by storage time. The texture value at H0 storage time was 8.22, then 7.97 at H10, 7.42 at H20, and 7.06 at H30. Since Fcount (572.36) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour, based on the ANOVA results in Appendix 4, showed a significant effect on texture values. The highest texture value was obtained in treatment P1 with storage time H0 (8.46), while the lowest texture value was obtained in treatment P2 with storage time H30 (6.32). Since Fcount (40.31) > Ftable (2.51) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

Aluminum foil packaging has a water vapor permeability of only 40–60 g/m, which is much lower than polypropylene packaging, which has a water vapor permeability of 100–123 g/m. This difference can cause a decrease in panelists' evaluation of the organoleptic texture properties of the product (Undurraga et al., 2007). In a study by (Nafissaturrohmah, 2024), the highest texture value was obtained in aluminum foil packaging. The high texture score given by panelists was attributed to the ability of aluminum foil packaging to maintain impermeable conditions during storage. Elisabeth et al. (2023) also stated that aluminum foil packaging has a strong capability to maintain product quality during the packaging and storage process.

4. Taste Value

The results of the taste quality test on instant cendol in different packaging during room temperature storage can be seen in Table 4.

Table 4. Aroma value of instant cendol made from snakehead fish flour in different packaging during storage at room temperature.

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	
P_1	$8{,}23^{e}$	$7{,}96^{de}$	$7{,}61^{c}$	$7{,}36^{bc}$	$7{,}79 \pm 0{,}38^{c}$
P_2	$8{,}04^{de}$	$7{,}67^{c}$	$7{,}27^{b}$	$6{,}71^{a}$	$7{,}42 \pm 0{,}57^{a}$
P_3	$8{,}12^{e}$	$7{,}88^{d}$	$7{,}55^{c}$	$7{,}21^{b}$	$7{,}69 \pm 0{,}39^{b}$
Average	$8{,}13 \pm 0{,}09^{d}$	$7{,}84 \pm 0{,}15^{c}$	$7{,}48 \pm 0{,}18^{b}$	$7{,}09 \pm 0{,}34^{a}$	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 4, the taste value of instant cendol made from snakehead fish flour for P1 packaging was 7.79, categorized as having a specific sweet taste characteristic of instant cendol. The taste value of instant cendol made from snakehead fish flour for P2 packaging was 7.42, categorized as having a specific cendol taste with slight sweetness, while the taste value for P3 packaging was 7.69, categorized as having a specific sweet cendol taste.

The analysis of variance (ANOVA) results showed that the taste value of instant cendol made from snakehead fish flour was significantly affected by differences in packaging types, where the Fcount value (74.58) > Ftable 5% (3.40) at a 95% confidence level. Therefore, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The ANOVA results in Appendix 5 also indicated that the taste value of instant cendol made from snakehead fish flour was significantly affected by storage time. The taste value at H0 storage time was 8.13, then 7.84 at H10, 7.48 at H20, and 7.09 at H30. Since Fcount (309.97) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour, based on the ANOVA results, showed a significant effect on taste values. The highest taste value was obtained in treatment P1 with storage time H0 (8.23), while the lowest taste value was obtained in P2 packaging with storage time H30 (6.71). Since Fcount (40.31) > Ftable (2.51) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

According to (Sarastuti & Yuwono, 2015), the taste value during storage tends to decrease from the beginning of storage until day 28. This decline occurs due to microbial growth in food products during storage, which can damage fats and produce degraded flavor characteristics. In this study, the best taste value was found in aluminum foil packaging, which occurs because aluminum foil has different abilities in absorbing light and gases, thereby influencing the flavor components present in the product (Putri et al., 2020). In a previous study, (Dewi et al., 2022) reported that the highest average taste value was obtained in cookies packaged with aluminum foil. The taste quality of tofu-waste cookies packaged in aluminum foil was better maintained because the packaging is light-impermeable, which helps preserve the flavor quality of the cookies.

Proximate Analysis

1. Water Content

The results of testing the water content of instant cendol in different packaging with room temperature storage can be seen in Table 5.

Table 5. Water content value of instant cendol made from snakehead fish flour in different packaging during storage at room temperature.

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	
P_1	3,28	3,78	4,76	5,82	4,41±1,12^{a}
P_2	3,66	4,05	5,40	6,60	4,93±1,34^{b}
P_3	3,51	3,97	5,13	6,10	4,68±1,17^{ab}
Average	3,48±0,19^{a}	3,93±0,14^{ab}	5,10±0,32^{b}	6,17±0,40^{c}	

Description: P1 (Aluminum Foil Packaging), 2P (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 7, the moisture content of instant cendol made from snakehead fish flour for P1 packaging was 4.41%, the moisture content for P2 packaging was 4.93%, and the moisture content for P3 packaging was 4.68%.

The analysis of variance (ANOVA) results showed that the moisture content of instant cendol made from snakehead fish flour was significantly affected by differences in packaging types, where the Fcount value (5.69) > Ftable 5% (3.40) at a 95% confidence level. Therefore, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The ANOVA results in Appendix 6 also indicated that the moisture content of instant cendol made from snakehead fish flour was significantly affected by storage time. This is supported by (Arizka & Daryatmo, 2015), who stated that moisture content in packaged products tends to increase due to the influence of air humidity and storage room temperature. The moisture content of instant cendol made from snakehead fish flour at H0 storage time was 3.48%, then increased to 3.93% at H10, 5.10% at H20, and 6.17% at H30. Since Fcount (93.77) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour on moisture content, based on the ANOVA results, showed no significant effect, where Fcount (0.34) < Ftable (2.51) at the 95% confidence level. Therefore, H_0 was accepted, and the Honestly Significant Difference (HSD) test was not conducted.

Based on the results shown in Table 7, the highest moisture content was found in the P2 packaging treatment, reaching 7.00%. It is known that polypropylene (PP) packaging materials, as reported by (Omodara et al., 2021), do not provide good protection against oxygen and water vapor transmission, which can cause the product to become less crispy and more susceptible to mold growth. Meanwhile, the lowest moisture content was found in the aluminum foil (AL) packaging treatment, which was 6.63%. Aluminum foil packaging can prevent product deterioration because it has low permeability to water vapor. According to (Hendrasty, 2013), aluminum foil packaging has good resistance to moisture, is anti-migration against water and microorganisms, and its use can also extend the shelf life of the product.

2. Ash Content

The results of observations of ash content in instant cendol made from snakehead fish flour in different packaging with room temperature storage can be seen in Table 6.

Table 6. Value of instant cendol content of snakehead fish flour in different packaging during storage at room temperature

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	
P_1	3,98	4,18	5,08	5,93	4,79±2,69
P_2	4,01	5,12	5,77	6,69	5,40±3,37
P_3	4,06	4,77	5,41	6,41	5,16±3,00
Average	4,02±0,57^{a}	4,69±1,43^{ab}	5,42±1,05^{b}	6,34±1,15^{c}	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 6, the ash content of instant cendol made from snakehead fish flour for P1 packaging was 4.79%, the ash content for P2 packaging was 5.40%, and the ash content for P3 packaging was 5.16%.

The analysis of variance (ANOVA) results in Appendix 7 showed that the ash content of instant cendol made from snakehead fish flour was not significantly affected by differences in packaging types, where Fcount (2.87) < Ftable (3.40) at a 95% confidence level. Therefore, H_0 was accepted, and the Honestly Significant Difference (HSD) test was not conducted. According to (Handayani, 2016), the ash content value is generally not significantly affected by different types of packaging, but it can be significantly influenced by storage treatments.

The ANOVA results also indicated that the ash content of instant cendol made from snakehead fish flour was significantly affected by storage time. The ash content at H0 storage time was 4.02%, then increased to 4.69% at H10, 5.42% at H20, and 6.34% at H30. Since Fcount (22.71) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour on ash content, based on the ANOVA results in Appendix 6, showed no significant effect, where Fcount (0.31) < Ftable (2.51) at the 95% confidence level. Therefore, H_0 was accepted, and the Honestly Significant Difference (HSD) test was not conducted.

Based on the results shown in Table 6, the highest ash content was found in the PP packaging treatment, reaching 5.40%, while the lowest ash content was found in the aluminum foil (AL) packaging treatment, which was 4.79%. Based on the analysis, aluminum foil packaging was considered the best packaging material, because it has several advantages compared to PP and combination packaging types. Aluminum foil packaging is lighter than steel, non-toxic, has low water vapor permeability, and can prevent gas penetration, which helps maintain product quality (Julianti & Nurminah, 2006).

3. Protein Content

The results of observations of protein content in instant cendol made from snakehead fish flour in different packaging during storage at room temperature can be seen in Table 7.

Table 7. Protein content value of instant cendol made from snakehead fish flour in different packaging during storage at room temperature.

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	
P_1	7,96	6,49	5,14	4,14	5,93±1,66^{b}

P_2	7,66	6,03	4,81	3,20	5,43±1,89^{a}
P_3	7,76	6,22	5,10	3,86	5,74±1,66^{ab}
Average	7,79±0,15^{d}	6,24±0,23^{c}	5,02±0,18^{b}	3,73±0,48^{a}	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 7, the protein content of instant cendol made from snakehead fish flour for P1 packaging was 5.93%, the protein content for P2 packaging was 5.43%, and the protein content for P3 packaging was 5.74%.

The analysis of variance (ANOVA) results showed that the protein content of instant cendol made from snakehead fish flour was significantly affected by differences in packaging types, where Fcount (5.48) > Ftable (3.40) at a 95% confidence level. Therefore, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The ANOVA results also indicated that the protein content of instant cendol made from snakehead fish flour was highly significantly affected by storage time. The protein content at H0 storage time was 7.79%, then decreased to 6.24% at H10, 5.02% at H20, and 3.73% at H30. Since Fcount (189.67) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour on protein content, based on the ANOVA results, showed no significant effect, where Fcount (0.56) < Ftable (2.51) at the 95% confidence level. Therefore, H_0 was accepted, and the Honestly Significant Difference (HSD) test was not conducted.

Based on the results shown in Table 7, the highest protein content was found in the aluminum foil (AL) packaging treatment, which was 5.93%. According to (Handayani, 2016), aluminum foil packaging tends to maintain higher protein content, which is associated with the lower moisture content in products packaged with aluminum foil. Meanwhile, the lowest protein content was found in the PP packaging treatment, which was 5.43%.

Protein content is closely related to moisture content, because higher moisture levels in food products promote faster microbial growth. Water acts as a medium for microbial growth, and an increase in microbial activity can lead to a decrease in protein content (Handayani, 2016). In addition, longer storage duration can also reduce protein content, which is consistent with the findings of (Sutrisno, 2012), who stated that protein degradation tends to occur during prolonged storage processes.

4. Fat Content

The results of observations of the fat content of instant cendol made from snakehead fish flour in different packaging during storage at room temperature can be seen in Table 8.

Table 8. Protein content value of instant cendol made from snakehead fish flour in different packaging during storage at room temperature.

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	
P_1	4,14	3,50	2,62	2,19	3,11±0,88
P_2	4,22	3,61	2,94	2,84	3,40±0,64
P_3	4,19	3,67	2,79	2,25	3,23±0,87
Average	4,18±0,04^{d}	3,59±0,09^{c}	2,78±0,16^{b}	2,43±0,36^{a}	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination

Packaging)

Based on the data presented in Table 8, the fat content of instant cendol made from snakehead fish flour for P1 packaging was 3.11%, the fat content for P2 packaging was 3.40%, and the fat content for P3 packaging was 3.23%.

The analysis of variance (ANOVA) results in Appendix 9 showed that the fat content of instant cendol made from snakehead fish flour was not significantly affected by differences in packaging types, where Fcount (3.34) < Ftable (3.40) at a 95% confidence level. Therefore, H_0 was accepted, and no further test was conducted. According to (Nafissaturrohmah, 2024), the fat content value is generally not significantly affected by different types of packaging, but it is significantly influenced by storage duration.

The ANOVA results also indicated that the fat content of instant cendol made from snakehead fish flour was highly significantly affected by storage time. The fat content at H0 storage time was 4.18%, then decreased to 3.59% at H10, 2.78% at H20, and 2.43% at H30. Since Fcount (72.08) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour on fat content, based on the ANOVA results in Appendix 6, showed no significant effect, where Fcount (0.99) < Ftable (2.51) at the 95% confidence level. Therefore, H_0 was accepted, and the Honestly Significant Difference (HSD) test was not conducted.

Based on Table 8, the highest fat content was found in the P2 packaging treatment, which was 3.35%, while the lowest fat content was found in the P1 packaging treatment, which was 3.11%. However, based on the overall analysis, the best packaging was aluminum foil (P1). According to (Nafissaturrohmah, 2024), aluminum foil packaging is the most effective material in maintaining lipid oxidation stability. This capability is related to its protective barrier properties against light and temperature changes from both internal and external environments, thereby preventing damage to the fat structure due to heat. In addition, aluminum foil packaging materials have molecules that are relatively stable and do not easily undergo chemical reactions or migrate into the food due to heat, making them suitable for environments with high light intensity and temperature (Kerry, 2012).

The least effective packaging was found in the P2 treatment, because this packaging is less capable of preventing lipid oxidation, as it has low density and is light-permeable (El-Baset & Al-Mosehly, 2023). This is also supported by Cantika & Junianto (2021), who stated that P2 packaging is a low-density packaging material, which often requires combination with other packaging materials to prevent the formation of free fatty acids caused by exposure to light and heat.

Number Yeast Mold (YM)

The results of AKK's observations on instant cendol made from snakehead fish flour in different packaging during storage at room temperature can be seen in Table 9.

Table 9. AKK value of instant cendol with snakehead fish flour against different packaging during storage at room temperature

Treatment (Packaging)	Day				Average
	D_0	D_{10}	D_{20}	D_{30}	

P_1	3,20	4,23	4,78	5,09	$4{,}32 \pm 0{,}83^{a}$
P_2	3,48	4,35	4,90	5,26	$4{,}50 \pm 2{,}32^{c}$
P_3	3,42	4,29	4,81	5,16	$4{,}42 \pm 2{,}27^{b}$
Average	$3{,}37 \pm 0{,}44^{a}$	$4{,}29 \pm 0{,}19^{b}$	$4{,}83 \pm 0{,}19^{c}$	$5{,}17 \pm 0{,}26^{d}$	

Description: P1 (Aluminum Foil Packaging), P2 (Polypropylene Packaging), P3 (Combination Packaging)

Based on the data presented in Table 9, the yeast and mold count (YMC) value of instant cendol made from snakehead fish flour for P1 packaging was 4.32, the YMC value for P2 packaging was 4.50, and the YMC value for P3 packaging was 4.42.

The analysis of variance (ANOVA) results in Appendix 10 showed that the yeast and mold count (YMC) of instant cendol made from snakehead fish flour was highly significantly affected by differences in packaging types, where Fcount (21.67) > Ftable (3.40) at a 95% confidence level. Therefore, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The ANOVA results also indicated that the yeast and mold count (YMC) of instant cendol made from snakehead fish flour was highly significantly affected by storage time. The YMC value at H0 storage time was 3.37, then increased to 4.29 at H10, 4.83 at H20, and 5.17 at H30. Since Fcount (1320.38) > Ftable (3.01) at the 95% confidence level, H_0 was rejected, and the analysis was continued with the Honestly Significant Difference (HSD) test.

The interaction between packaging type and storage duration of instant cendol made from snakehead fish flour on yeast and mold count (YMC), based on the ANOVA results in Appendix 10, showed no significant effect, where Fcount (1.52) < Ftable (2.51) at the 95% confidence level. Therefore, H_0 was accepted, and the Honestly Significant Difference (HSD) test was not conducted.

Based on Table 10, the highest yeast and mold count (YMC) was found in the PP packaging treatment, with an average value of 4.50, while the lowest YMC value was found in the aluminum foil (AL) packaging treatment, with an average value of 4.32. In this study, it can be observed that the longer the storage duration, the higher the yeast and mold count obtained. This finding is consistent with the study by (Pribadi, 2019), which reported that longer storage time of chocolate bakpia pathok resulted in higher yeast and mold growth.

Several factors influence microbial growth, including water activity in food materials, storage temperature, processing temperature, and oxygen availability. These factors play an important role in determining the rate of yeast and mold development during product storage.

CONCLUSION

Aluminum foil packaging (P1) is the best packaging for instant cendol products, as it achieved the highest organoleptic values and produced low levels of moisture content, ash content, fat content, and yeast and mold counts from day 0 to day 30. In addition, it resulted in higher protein and carbohydrate contents during the storage period from day 0 to day 30.

Polypropylene packaging (P2) is less suitable for instant cendol products because it showed the lowest organoleptic values and resulted in higher moisture content, ash content, fat content, and yeast and mold counts from day 0 to day 30. In addition, it produced lower protein and carbohydrate contents during the storage period from day 0 to day 30.

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