Effect of Packaging Type and Storage Time on the Quality of Wheat Flour

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Abstract. The wheat flour quality is influenced by several factors, including the packaging type used and the length of storage time. This research aims to determine the effect of packaging type (polypropylene and polyethylene) and storage time on the wheat flour quality at PT XYZ. The wheat flour quality described refers to SNI No. 01-3751-2018, including water content, ash content, protein content, and organoleptic properties. The research results show that the packaging type and storage time affect the wheat flour quality. The analysis results show that wheat flour produced and packaged using polypropylene and polyethylene with variations in storage time shows a real influence on the wheat flour quality. The analysis results showed that the smallest water content in polyethylene packaging was 13.28% with a storage time of 21 days, the smallest ash content in the polypropylene packaging type was 0.56% with a storage time of 9 days, and the highest protein content was 15.24% in the polypropylene packaging type with a storage time of 14 days. Meanwhile, the analysis of organoleptic properties including color tests and aroma tests did not have a significant effect on the wheat flour quality.

1 Introduction

Wheat is one of the first food crops spread throughout the world because it has various benefits that are processed for raw materials for the production process of wheat flour. Basically, wheat flour is the basic ingredient that can be used in the process of making bread. Based on the level of food consumption needs, bread is a staple food for more than three-quarters of the world's population. Therefore, this will certainly cause food security for bread making to depend on the availability of this item, thus causing higher demand for wheat in the food industry. Wheat is a raw material whose utilization is not only used as an ingredient for making bread, but in the food industry this wheat can be processed into various processed food products such as pasta, semolina, bulgur and couscous. Usually, its use can be adjusted to the habits and patterns of people in various countries [1]. The Indonesian Wheat Flour Producers Association (APTINDO) reported that there was an increase in flour consumption when compared to the first half of 2013 by 2.78 million metric tons or 5.4% [11]. The specialty of wheat flour among other cereals is its ability to form a gluten network when the flour is moistened with water and given mechanical force.

Based on protein content, wheat flour is divided into three types, namely, Hard Flour (high protein wheat flour) is flour with a protein content of around 13-14% and is used for making bread and noodles, Medium flour (medium protein wheat flour) is flour with a protein content of 9.5-11% usually used in making bread, noodles, and various kinds of cakes, as well as biscuits and Soft flour (low protein wheat flour) is flour that contains protein of 7-8.5% and is used for making cakes and biscuits.

Some of the components that determine the quality of wheat flour are moisture content, ash content, protein, gluten, whiteness, fineness, and viscosity. Packaging material is one of the main factors that affect the quality of wheat flour during storage. As a result of the shelf-life of wheat flour, biochemical changes can impact its nutritional composition, functional properties, and sensory acceptability. This will directly impact its storage stability [10]. The storage process is closely related to the quality of a stored material, hence the need for packaging with various types of packaging during the storage process in order to maintain the quality of the packaged product.

Food packaging is an important step to ensure product quality because it provides protection against damage and deterioration during storage, transportation, and distribution [2]. Packaging can prevent or reduce damage, protect the ingredients inside from pollution and physical disturbances such as friction and impact. In addition, food packaging can be used to contain or wrap food, both in direct and indirect contact with food. Quality criteria for packaged food products include the availability of healthy, clean, unpolluted food with...
minimal losses during transportation, hygienic conditions, and reasonable prices for consumers. Although packaging has no direct relationship with production, storage, marketing, and distribution, it plays an important role in the safety and quality of the product after it reaches consumers [2]. Bottled oxygen can increases the rate of oil oxidation and the growth of microorganisms [15].

The type of packaging that affects the shelf life of food is related to the ability of a material to control light, oxygen concentration, moisture content, heat transfer, contamination and bio-attack. Packaging materials used vary from paper, plastic, glass, metal and laminated fiber. The choice of form and type of packaging must be adjusted to the product to be packaged. One effective technique is to use non-permeable packaging materials that limit exposure to oxygen and moisture, thereby reducing flour biochemical reactions and associated quality problems [6].

Selecting suitable packaging materials is critical in improving the storage stability of stored flour. Therefore, it is important to identify suitable packaging materials that can maintain the nutritional, microbial and sensory properties of wheat flour over long storage periods. PT XYZ uses Polyethylene (PE) and Polypropylene (PP) plastic types. The main reason for using this packaging is because of the difference in high density, then resistance to temperature and humidity, and water absorption. In addition, plastic has unique properties and also has a very transparent color and makes it easy to see changes in product color from outside the package [11].

Some of the superior properties of polypropylene packaging are lightweight and easy to shape, not easy to tear, transparent, naturally white and has good mechanical properties, making it easy for handling and distribution. Based on the description above, to ensure the use of proper packaging in the process of storing wheat flour products, this study was conducted to observe the extent of the effect of packaging type and length of storage time on the quality of wheat flour products at PT XYZ.

2 Methodology

2.1 Materials and Equipment

This research used wheat flour from PT XYZ, Medan City, North Sumatra Province, Indonesia. The equipment used were near infrared, moisture analyzer, minolta colorimeter, pekar test, digital balance, and seal machine.

2.2 Preparation and Analyzing the Quality of Flour

Wheat goes through the first cleaning process and then goes through the dampening process. After the dampening process is carried out, the wheat will be tempered first to go to the next stage. Wheat that has gone through the conditioning process will be ground using a roll mill as a wheat crushing tool. Then it passes through the sieving process and enters the flour chain to be stored in the mixing bin. The flour will pass through the scale and additives are added. After completing the mixer process, the flour then enters the carousel as a flour packing tool. Then wheat flour is taken from packing to be packaged using polypropylene and polyethylene packaging as experimental samples. After that, each sample that has been packaged is stored in the warehouse at room temperature. Samples were checked and analyzed during storage times of 2 days, 9 days, 14 days, and 21 days. The samples were tested using a moisture analyzer to analyze the water content. Meanwhile, to see the ash content and protein content, the samples were tested using a near infrared device. For organoleptic properties, aroma will be checked through the sense of smell and color will be tested with a minolta colorimeter.

3 Results and Discussion

3.1 Moisture Content

Figure 1 shows the effect of packaging type and storage time on moisture content. In polypropylene packaging, the highest moisture content was obtained on day 9 at 14.22% and the lowest moisture content on day 21 at 14.05%. In polyethylene packaging, the highest water content was obtained on day 2 at 13.51% and the lowest water content on day 21 at 13.29%. According to SNI No. 01-3751-2018, the maximum moisture content of wheat flour is 14.5% [3]. Thus, the research conducted has met the SNI for all types of packaging.

![Fig. 1. Effect of Storage Time on Moisture Content](image-url)
in a material will decrease. Storage time that is too long can reduce or damage the quality of the flour thus causing degradation of its components such as protein, starch, and lipids due to biochemical reactions resulting in changes in organoleptic properties [14]. The moisture content on the surface of the product is influenced by the humidity level of the surrounding air, if the moisture content of the product is low while the surrounding air is high, there will be absorption of water vapor so that the product becomes moist or the moisture content in the product becomes high [11].

The packaging material used greatly affects the hygroscopic properties of flour [7]. At PT XYZ, polypropylene packaging material has a larger pore size than polyethylene packaging material. This causes the moisture content in polypropylene packaging to tend to be higher than polyethylene packaging because the difference in pore size causes water absorption from the environment. The larger the pore size, the easier the product will absorb water from the environment [4]. Moisture content can affect quality degradation. The higher the water content, the easier the damage to the product caused by microorganisms that utilize water as a growth medium. The water content in food affects the product's resistance to microbial growth.

3.2 Ash Content

Figure 2 shows the effect of packaging type and storage time on ash content. In polypropylene packaging, the highest ash content was obtained on day 9 at 0.62% and the lowest ash content on day 2 at 0.57%. In polyethylene packaging, the highest ash content was obtained on day 2 at 0.60% and the lowest moisture content on day 21 at 0.56%. According to SNI No. 01-3751-2018, the maximum ash content of wheat flour is 7.0% [3]. Thus, the research conducted has met the SNI for all types of packaging.

![Fig. 2. Effect of Storage Times on Ash Content](image)

Based on Figure 2, the type of packaging and the length of storage time significantly affect the ash content. The ash content of the polypropylene packaging fluctuated during the storage process. This is because at the time of observation, the humidity of the surrounding air tended to change. Meanwhile, the ash content of polyethylene packaging decreased during the storage time. The value of ash content along with the length of storage decreases. [8]. There is a reduction in the value of minerals in the material caused by the influence of water-soluble nutrients and lost with water vapor and reactions that take place during storage [5]. Minerals which are classified as inorganic nutrients are referred to as the ash element in food, because it turns out that if food is burned, organic elements will disappear and the remaining organic matter (ash) consists of minerals [4].

At PT XYZ, polypropylene packaging material has a larger pore size than polyethylene packaging material. When the pores of a material are larger, it is easy for the product to absorb water from the environment. The ash content of polypropylene packaging tends to be higher than that of polyethylene packaging. One of the contributing factors is the difference in pore size of the packaging material. High ash content will affect the color of the flour which tends to be higher and the texture is coarser.

3.3 Protein Content

Figure 3 shows the effect of packaging type and storage time on protein content. In polypropylene packaging, the highest protein content was obtained on day 2 at 15.24% and the lowest protein content on day 21 at 15.09%. In polyethylene packaging, the highest protein content was obtained on day 2 at 15.17% and the lowest protein content on day 21 at 15.05%. According to SNI No. 01-3751-2018, the minimum protein content of wheat flour is 7.0% [3]. Thus, the research conducted has met the SNI for all types of packaging.

![Fig. 3. Effect of Storage Times on Protein Content](image)

Based on Figure 3, the type of packaging and the length of storage time have a real effect on the value of protein content although it is not so significant. Protein content decreased during the storage process for all types of packaging. The longer the storage, the protein concentration decreases due to the hydrolysis of protein due to acids formed naturally due to storage caused by lactic acid bacteria degrading lactose into lactic acid which results in low protein concentration [7]. Protein degradation occurs due to the influence of heat, pH and chemical-enzymatic reactions that take place during storage [9]. The decrease in protein content occurs due to the activity of proteolytic bacteria that can digest protein. The number of bacteria that appear on the packaging is closely related to the pores of the
packaging used. The more oxygen in the environment, the more optimal the growth of proteolytic bacteria will be [11].

3.4 Organoleptic Properties

3.4.1 Aroma

Aroma is one of the parameters that affect consumer interest because if the aroma of the product is good, it will give a good assessment of the product. Aroma is measured using the sense of smell (nose), because in many cases food is liked by consumers determined by the aroma or smell of the food. In the food industry, odor testing is very important because it can quickly provide the results of consumer acceptance assessment of the resulting production [10].

The aroma and odor of food flavors can be associated with the presence of one or more compounds that give the impression of certain foods if only smelled. The aroma of an ingredient can be caused by one or more components that are characteristic of the aroma of the food ingredient, while other components only give nuances to the whole [8]. Based on the analysis conducted, it shows that the length of storage time has no significant effect on the aroma of wheat flour for all types of packaging. During the 21-day storage period, wheat flour stored with polypropylene and polyethylene packaging materials did not smell rancid. However, at 21 days storage for polypropylene packaging material, the texture changes, which is coarser and there are lumps of flour. This is common because the pores of polypropylene packaging are larger than polyethylene packaging, so polypropylene packaging easily absorbs water and has high humidity due to the influence of the surrounding environment.

3.4.2 Color

The color of a food product is determined by various factors, namely the color, brightness, and clarity of the product color. Changes in the color of wheat flour can be caused by environmental conditions such as oxygen contained in the package or outside the package, temperature, and microbial activity. In various types of products, color changes can also change nutritional value. In addition, color changes can determine the length of storage quality of a product [12]. The color of foodstuffs is usually measured in L*a*b* units which is an international standard of color measurement, adopted by CIELab (Commission Internationale d’Eclairage) [9]. The L* value represents the lightness value which has a range of values from 0 (black) to 100 (white) with a value of 50 representing neutral gray. The a* value represents reflected light that produces a red-green mixed chromatic color (redness). The b* value represents the chromatic color of the blue-yellow mixture (yellowness) [13]. The observation results of wheat flour color are presented in the following table.

Table 1. Observation Results of Wheat Flour Color at PT XYZ

<table>
<thead>
<tr>
<th>Type of Packaging</th>
<th>Storage Duration (Day)</th>
<th>L*</th>
<th>a*</th>
<th>b*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polypropylene</td>
<td>2</td>
<td>91.55</td>
<td>-0.31</td>
<td>10.04</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>91.50</td>
<td>-0.30</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>91.46</td>
<td>-0.29</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>91.33</td>
<td>-0.20</td>
<td>9.6</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>2</td>
<td>91.63</td>
<td>-0.31</td>
<td>10.13</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>91.58</td>
<td>-0.30</td>
<td>10.09</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>91.55</td>
<td>-0.25</td>
<td>10.04</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>91.48</td>
<td>-0.21</td>
<td>10.02</td>
</tr>
</tbody>
</table>

4 Conclusion

The sample testing process using polypropylene and polyethylene packaging types with varying storage times has been carried out. Based on the analysis results obtained, the water content test and ash content test on polypropylene packaging material fluctuated while the protein content test decreased. Fluctuations occur due to environmental humidity factors. While the test of water content, ash content and protein content in polyethylene packaging material has decreased. Analysis of the use of polypropylene and polyethylene packaging materials with a storage time of 21 days carried out at PT XYZ still meets SNI No. 01-3751-2018. The highest water content is found in polypropylene packaging material of 14.22% on the 9th day of observation. The highest ash content is found in polypropylene packaging material of 0.62% on the 9th day of observation. The highest protein content was found in polyethylene packaging material of 15.24% on the 2nd day of observation. In the analysis of organoleptic properties that the packaging material used gives a not so significant effect during the 21-day storage process.

References

6. S. Fasoyiro, R. Hovingh, H. Gourama, P. Cutter, Procedia Eng, **159** (2016)