The addition of sorbitol and glycerol to improve the physico-chemical and sensory characteristics of chocolate dodol

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Abstract. Dodol is a traditional food from Indonesia which made from glutinous rice flour, coconut milk, and sugar. Chocolate dodol is one variant of dodol that use cocoa powder on its formulation. Dodol has a sweet taste and chewy texture, but its shelf life is very short, i.e., 4-5 days only. Therefore it needs an additional humectant, such as glycerol and sorbitol, to decrease the water activity (aw) of the product and increase its shelf life. This research aimed to determine the effect of glycerol and sorbitol addition to the physical, chemical and sensory characteristics of chocolate dodol. The addition of glycerol and sorbitol to the chocolate dodol formulation were 0%, 6%, 8%, and 10%. The addition of sorbitol and glycerol to chocolate dodol product decreased water activity, increased texture characteristic, and have no significant difference in sensory preferences. In the same concentration, the addition of glycerol has a lower aw than sorbitol. Panelists most preferred chocolate dodol with 6% sorbitol addition. It have aw 0,74; L*-a*-b* value 25,47; 3,66 and 0,73.

1. Introduction
Indonesia is the largest producer of cocoa beans in the world after Cote d'Ivoire and Ghana [1]. More than 90% of cocoa plantations are managed by smallholder with the land ownership under 5 hectares [2]. Cocoa and chocolate become a concern because of the content of its active compounds. Polyphenol, catechin, and epicatechin are the bioactive compounds inside the cocoa seed. Its polyphenol being as an antioxidant which has a protective role against oxidative stress that is involved in cardiovascular and cerebrovascular disease [3].

The way to improve the value added of cocoa beans is product diversification[4]. Cocoa can proceed into several products, one of them is chocolate dodol. Dodol is a traditional food from West Java, Indonesia that formulated from glutinous rice flour, coconut milk, and sugar. Dodol is an intermediate moisture food which the moisture 10-40%; aw 0,70-0,85; sweet taste, soft texture and elastic. Chocolate dodol is proceeded by mixing and heating coconut milk, glutinous rice flour, rice flour, chocolate powder, and sugar [5, 6]. The shelf life of chocolate dodol is fairly short, 4-5 days.

As an intermediate moisture food, dodol is easily damaged. The deterioration of dodol is caused by its aw 0,7-0,85. These water activity condition will cause an activity of foodborne microorganism and chemical reaction that damage food quality, such as rancidity. This deterioration can be inhibited by adding a humectants [7]. Humectants are a food additive that binds water of the product and control aw.
The hydroxyl group of humectants has an affinity to form hydrogen bonds with water; this will decrease the free water ability [8]. The decreasing of free water ability will inhibit microorganism activity and chemical reactions that accelerate food deterioration. The humectant used in a food product is sucrose, fructose, lactose, mannitol, honey, sorbitol, and glycerol [9].

Among the various types of humectants, sorbitol and glycerol are often used for a food product. Some previous studies stated that the addition of glycerol and sorbitol can improve product quality. Glycerol reduced the product humidity until 60%. The addition of 4% glycerol in khoa caused decreasing the $a_w$ without significantly affect its textural parameter [10]. The best jerky formulation was produced by adding 15% glycerol compare to sorbitol and control sample [11]. Badola [8] reported that the addition of 20% sorbitol to khoa product has the maximum water activity reduction compared with corn syrup, maltodextrin, polydextrose, and mannitol. While Syafutri [12] reported that panelists most preferred the jelly candies with the addition of 20% sorbitol. The addition of humectant to reduce the $a_w$ of chocolate dodol has not been studied yet. So, this study was conducted to determine the effect of adding sorbitol and glycerol to the physico-chemical and sensory characteristics of chocolate dodol.

2. Materials and Methods

2.1. Materials
Material for making chocolate dodol are glutinous rice flour Rosebrand, rice flour Rosebrand, coconut milk, chocolate powder from Griya Cokelat Nglanggeran, sugar Gulaku. Glycerol and Sorbitol food grade (70%) were obtained from Bratachem.

2.2. Chocolate Dodol Processing
Chocolate dodol processing followed the method of Nurhayati [13]. Thick coconut milk and sugar were mixed and heated (70°C, 15 minutes). Glutinous rice flour, rice flour, chocolate powder, and runny coconut milk were mixed, then added to sugar dough. Sorbitol and glycerol (6%, 8% and 10%) were added then the dough was mixed until perfectly gelatinized. Chocolate dodol was cooled to a temperature 28°C.

2.3. Physicochemical Analysis
Each sample of chocolate dodol was tested for water activity with a meter Pawkit Decagon, color using Chromameter CR-400 Konika Minolta and texture using Llyod Texture Analyzer.

2.4. Sensory Analysis
Sensory evaluation using hedonic test method involving 25 panelists for 7 samples (original chocolate dodol, 3 samples chocolate dodol+glycerol and 3 samples chocolate dodol+sorbitol). Taste, color, aroma, adhesiveness, elasticity and overall were evaluated by providing score 1-5 (5=really like, 4=like, 3=rather like, 2=rather dislike, 1=dislike).

3. Result and Discussion

3.1. Water Activity of Chocolate Dodol
Dodol is an intermediate moisture food that has a water activity ($a_w$) 0,65-0,90 [14]. Based data on Table 1 the $a_w$ of chocolate dodol is 0,54-0,79. The highest $a_w$ was chocolate dodol original, while the lowest was chocolate dodol with the addition of 10% glycerol. At the same concentration, glycerol could reduce the water activity lower than sorbitol. The higher concentration of sorbitol and glycerol, the lower water activity of chocolate dodol. Glycerol and sorbitol have hydroxyl group. The hydroxyl group functions to bind free water from product and form the hydrogen bonds with water. So, the more humectants added, the lower $a_w$ of product [15].

Jariyah [14] reported that the addition of 8% sorbitol in Mangulu, traditional food from Sumba Timur-Nusa Tenggara Timur, decreased its water activity into 0,57. While this research data was the same
as Syamsir and Sitanggang [7] did. They reported that the ability of glycerol to reduced the water activity of product higher than sorbitol. The addition of 10% glycerol to dodol products produced \( a_w \) 0.83; while 10% sorbitol produced \( a_w \) 0.86.

### Table 1. Water Activity of Chocolate Dodol.

| Chocolate Dodol | Water activity (\( a_w \)) |
|-----------------|---------------------------|
| Original        | 0.79^e                    |
| Glycerol 6%     | 0.69^c                    |
| Glycerol 8%     | 0.59^b                    |
| Glycerol 10%    | 0.54^a                    |
| Sorbitol 6%     | 0.73^d                    |
| Sorbitol 8%     | 0.73^d                    |
| Sorbitol 10%    | 0.72^d                    |

The amount of free water in food is known as water activity (\( a_w \)). Water activity plays an important role in damaged microbiological food. Water needs to add or remove in order to modify the \( a_w \) of food for preserving and control food quality. Each microorganism requires a different amount of water for growth. Bacteria grow well in a high \( a_w \) 0.91. Yeast requires medium \( a_w \) 0.87-0.91 while fungi require \( a_w \) 0.80-0.87, but they still grow slowly at \( a_w \) 0.75 such as Aspergillus [16]. Xerophilic fungi showed growth in the \( a_w \) 0.6-0.75 [17, 18]. The addition of glycerol and sorbitol reduced the \( a_w \) of chocolate dodol under 0.8. This condition prevented the growth of microorganism in the chocolate dodol.

### 3.2. Sensory Characteristic

The hedonic tests were conducted to determine the level of preference of the panelists for the product. Chocolate dodol original and chocolate dodol with the addition of sorbitol and glycerol were evaluated by 25 panelists. Six parameters (taste, color, aroma, adhesiveness, elasticity and overall) of each chocolate dodol were tested by giving score 1-5.

Based on sensory’s data (Table 2), chocolate dodol with the addition of 6% sorbitol was most preferred by panelists. Its preference score for all parameters has no significant difference with chocolate dodol original. The level of panelist preference to the chocolate dodol product was in the range of rather like to like. The preference result showed that there was no significant different between chocolate dodol original and chocolate dodol with the addition of 10% glycerol, 6% sorbitol and 8% sorbitol. The result of this study was the same as those conducted by Syamsir and Sitanggang [7] which reported that the addition of 5% and 10% glycerol to dodol have no significant different for all the sensory parameter compared with the original.

### Table 2. Sensory Characteristics of Chocolate Dodol.

| Chocolate Dodol | Sensory Parameters |
|-----------------|-------------------|
|                 | Taste | Colour | Aroma | Adhesiveness | Elasticity | Overall |
| Original        | 3.81^a | 3.89^a | 3.69^a | 3.47^a | 3.56^ab | 3.86^a |
| Glycerol 6%     | 3.28^b | 3.42^b | 3.47^a | 3.17^ab | 3.22^b | 3.28^b |
| Glycerol 8%     | 3.5^ab | 3.83^a | 3.67^a | 2.78^b | 3.17^b | 3.56^ab |
| Glycerol 10%    | 3.64^ab | 3.69^ab | 3.67^a | 3.33^a | 3.58^ab | 3.72^a |
| Sorbitol 6%     | 3.67^ab | 3.94^a | 3.81^a | 3.64^a | 3.86^a | 3.89^a |
| Sorbitol 8%     | 3.64^ab | 3.69^ab | 3.67^a | 3.25^a | 3.58^ab | 3.58^ab |
| Sorbitol 10%    | 3.53^ab | 3.89^a | 3.58^a | 3.53^a | 3.36^b | 3.67^a |

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3.3. Physical Characteristics

Colour test used Chromameter, while texture used Llyod texture analyzer. L* value with the scale 0-100 showed the brightness level of the product, from dark into white [19]. L* value of chocolate dodol was 23,93-26,57. This indicated that the color of chocolate dodol approach to black. Sugar caramelization or Maillard reaction occurs during chocolate dodol processing. Maillard is a complex reactions between reducing sugar and free amine groups from protein or amino acid [9]. Beside that, chocolate powder became natural brown coloring for the product. These two things that caused the color of chocolate dodol is brown-black.

| Chocolate dodol | L*   | a*  | b*  |
|----------------|------|-----|-----|
| Original       | 26,24 | 4,68 | 1,73 |
| Glycerol 6%    | 23,93 | 4,26 | 1,82 |
| Glycerol 8%    | 25,93 | 4,41 | 0,44 |
| Glycerol 10%   | 25,28 | 4,01 | 0,90 |
| Sorbitol 6%    | 25,47 | 3,66 | 0,73 |
| Sorbitol 8%    | 24,83 | 4,04 | 0,94 |
| Sorbitol 10%   | 25,52 | 4,05 | 1,04 |

Positive a* value 0-60 showed redness level, while negative a* value 0-(-60) showed the greenish level. a* value of chocolate dodol range between 3,53-4,88; this showed that the color of chocolate dodol was a little red. Positive b* value 0-60 showed yellowish level, while negative b* value 0-(-60) showed a bluish level. b* value of chocolate dodol range between 0,73-1,82; this showed that the color of chocolate dodol was a little yellow.

The texture of chocolate dodol measured by texture analyzer. There were five parameters; hardness, cohesiveness, adhesiveness, gumminess, chewiness (Table 4). The addition of sorbitol and glycerol has significant effect to the texture of chocolate dodol. The addition of sorbitol and glycerol made the chocolate dodol softer, more cohesive, and less adhesive.

| Chocolate dodol | Hardness (N) | Cohesiveness (N) | Adhesiveness (Nmm) | Gumminess (N) | Chewiness (N) |
|----------------|--------------|------------------|-------------------|---------------|--------------|
| Original       | 1545,17      | 0,46             | 278,55            | 710,54        | 5424,24      |
| Glycerol 6%    | 872,83       | 0,66             | 34,09             | 576,74        | 4856,59      |
| Glycerol 8%    | 715,17       | 0,73             | 6,32              | 512,49        | 4426,82      |
| Glycerol 10%   | 552,00       | 0,79             | 9,21              | 433,25        | 3722,71      |
| Sorbitol 6%    | 860,83       | 0,74             | 15,80             | 632,87        | 5501,99      |
| Sorbitol 8%    | 990,33       | 0,77             | 10,55             | 769,65        | 6771,10      |
| Sorbitol 10%   | 737,50       | 0,76             | 6,63              | 558,98        | 4817,93      |

Hardness is the resistance of the material to rupture due to the pressure applied. The addition of humectants reduced the value of hardness. There was a significant difference in the value of hardness between chocolate dodol original and chocolate dodol with the addition of humectants. Cohesiveness is the product’s ability to resist deformation. All chocolate dodol with the addition of humectants have higher cohesiveness value than the original. The adhesiveness is the work needed to pull away from the product from the surface. The addition of humectants reduced the adhesiveness of the product. Gumminess is the durability of the material to release or break due to compressive force. The addition of humectants decreased the gumminess of the product compared with the original. Chewiness is the pressure needed to chew samples to become the right consistency to swallow. The addition of humectants decreased the chewiness of the product compared to the original chocolate dodol.
Generally, the addition of humectants improved the texture quality of chocolate dodol. The same result also reported by Badula [18] Syamsir and Sitanggang [7], Sorapukdee [11] and Karimi [20].

4. Conclusion
Based on research data, we concluded that the addition of sorbitol and glycerol to chocolate dodol product, decreased water activity, increased texture characteristic, and have no significant difference in sensory preferences. Panelists most preferred chocolate dodol with the addition of 6% sorbitol. It have characteristics $a_w$ 0.74; L*-a*-b* value 25.47; 3.66 and 0.73. The hardness 860.83 N; cohesiveness 0.74 N; adhesiveness 15.80 N.m, gumminess 632.87 N and the chewiness 5501.99 N.

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