The Effect of Increased Level of Avocado (*Persea americana* Mill.) Seed Starch as Binding Agent on Physical Properties of the Liquorice Extract (*Glycyrrhiza glabra* Linn.) Lozenges

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Abstract: The utilization of avocado (*Persea americana* Mill.) seed has not been optimal even though it is known to be high in starch and can be used as a binder for formulation of the lozenges. The purpose of this study was to determine the effect of increased level of avocado (*Persea americana* Mill.) seed starch as a binding agent on the hardness and friability of liquorice (*Glycyrrhiza glabra* Linn.) extract lozenges using wet granulation method. The lozenges were made from four formulas based on different avocado seed starch concentrations of 5, 10, 15, and 20%. Evaluations of the lozenges included visual test, weight uniformity, size uniformity, hardness, friability and disintegration time. The result of hardness and friability test was analyzed with one-way ANOVA with 95% confidence level ($\alpha = 0.05$) followed by the Tukey HSD. It showed that 15% and 20% concentration of avocado seed starch meet the hardness specification of the lozenges with value 11,09 Kgf and 13,30 Kgf, respectively. The formula using 20% concentration of avocado seed starch meets the requirement of lozenges friability with value 0,45%. It can be concluded that the increased concentration of avocado starch as binder for the lozenges can increase the hardness and reduce the friability of the lozenges.

1 INTRODUCTION

Avocado (*Persea americana* Mill.) is a fruit that is commonly consumed as food and beverage ingredient. However, avocado seed is often considered not useful and is usually only disposed as a waste. An avocado seed contains carbohydrates consisting of 32.5% amylose and 67.5% amylopectin (Builders *et al.*, 2010). Amylopectin can form aggregates through the bonding process between particles, so it can be used as a binder of tablets (Kartika *et al.*, 2012). Builders *et al.* (2010) stated that granules made with avocado seed starch as a binder have higher mechanical strength compared to granules made with corn starch.

Based on these advantages, this study was conducted to determine the effect of increased level of avocado (*Persea americana* Mill.) seed starch as a binder on lozenges. From this, it is expected to produce a good lozenges that has a hardness value of 10-20 Kgf in order to be soluble slowly in the mouth (Lachman *et al*, 1986). The active substance used in this study used is liquorice (*Glycyrrhiza glabra* Linn.) extract that has antibacterial activity against *Streptococcus mutans*, a bacteria that causes dental caries (Chaiya *et al.,* 2013; Ajagannanavar *et al.*, 2014).

2 MATERIALS AND METHOD

2.1 Materials

The materials that are used in this research are tablet compression machine (Rimek), oven (Memmert), hardness tester, friability tester, tap density tester, disintegration tester, granule flow tester, blender (Philips), vacuum rotary evaporator (Eyela), sieve shaker, pH meter (LaMotte), microscope (Yakumi), Furnace (Barnstead Thermolyne), analytical balance (Ohaus), Liquorice powder (Herbal Anugrah Alam-Yogyakarta), ethanol 70%, Avocado seed, sucralose (JK Sucralose Inc), Mannitol (SPI Pharma-USA), magnesium stearate, aerosil (Cabot-China), sodium metabisulfite, aquadest dan $FeCl_3$, Iodium, $HCl_{(p)}$.

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2.2 Methods

2.2.1 Preparation The Liquorice Extract

Liquorice powder is macerated with 70% ethanol for three days. The macerate was then evaporated using a rotary evaporator to obtain a viscous extract. The characteristics of the extract were examined by the organoleptic test, pH measurement, ash content and chemical compound identification.

2.2.2 Isolation of Starch From Avocado Seed

The skin of avocado seed was peeled and washed, then mashed using a blender with the addition of 1: 1 water. Then filtered to take starch from the tissue. The filtrate was left for 12 hours to obtain starch deposits. When the sediment has been formed, the water was removed, then washed with clean water and re-deposited for three times, then deposited again with 3000 ppm $Na_2S_2O_5$ solution, according to the treatment of the fourth immersion. The starch deposits was dried in an oven at 50ºC. The dried starch was ground and then sieved through the number 60 sieve.

2.2.3 Avocado Seed Starch Characterisation

The test included organoleptic test, amylum identification (Departemen Kesehatan Republik Indonesia, 2014), ash content and weight loss on drying (Departemen Kesehatan Republik Indonesia, 2008).

2.2.4 The Preparation of Liquorice Extract Lozenges

Granules are prepared according to the formulas in Table 1. Mannitol, sucralose and liquorice extract were crushed slowly to make them homogeneous and added with the mucilage of avocado seed starch gradually. Then it was crushed and added with aquadest (F1 = 11 mL, F2 = 8 mL, F3 = 2 mL, F4 = 0 mL) to form a mass of banana breaking which then sieved with the number 14 sieve. The result was dried in an oven with temperature ± 50ºC for ± 24 hours. Dry granules were sieved with the number 18 sieve and then added with magnesium stearate and aerosil. The quality of the granules were examined, the characteristics included compressibility, flow properties, weight loss on drying and particle size distribution.

Table 1: The liquorice extract lozenges formula

Ingredients	Formula (%)			
	F1	F2	F3	F4
Liquorice Extract	2	2	2	2
10% Avocado seed starch mucilage	5	10	15	20
Sucralose	0,2	0,2	0,2	0,2
Mg Stearate	3	3	3	3
Aerosil	0,25	0,25	0,25	0,25
Mannitol ad	100	100	100	100

3 RESULT AND DISCUSSION

3.1 Liquorice Extract Characterisation

The results of the organoleptic test showed that the extract of liquorice had the black viscous liquid, dark brown coloured, aromatic odor and sweet taste. The sweet taste is due to the presence of glycyrrhizin, which 50 times sweeter than sugar (Nitalikar *et al.* 2010). The pH of liquorice extract was 5.52. This liquorice extract contained 3.8% of ash content. The results of phytochemistry screening showed that liquorice extract was positively contain flavonoids and tannins which have been known to have antibacterial activity against *Streptococcus mutans*, the bacteria that cause dental caries (Chaiya *et al.*, 2013).

3.2 Avocado Seed Starch Characterisation

Starch obtained in the form of fine powder had light brown colour, tasteless and odorless. Identification test for starch with iodine 0.005 N solution showed positive results. Weight loss on drying of 8.00% and ash content of 0.94%. That value obtained is higher than the Builder *et al.* (2010) requirement which sets the weight loss on drying and ash content of avocado seed starch by 7,81 ± 0,35% and 0,42 ± 0,10% respectively. The ash content of the starch indicated the presence of mineral content. In this case, the habitat of the avocado plant in Indonesia may affect the mineral content in the plant.

3.3 Granule Evaluation Results

The weight loss on drying of the granules from each formula were below the Voigt (1995) requirement with 5%, indicated that the water content of the

Table 2: Granules evaluation

Evaluation	F1	F2	F3	F4
Weight Loss on Drying (%)	2,38±0,03	2,82±0,03	2,20±0,04	2,79±0,05
Flow time (second)	4,34±0,26	4,26±0,26	4,54±0,26	4,50±0,23
Angle of Repose (°)	28,23±1,41	28,34±1,55	28,24±0,57	26,83±0,75
Compressibility (%)	3,65±0,58	4,66±1,55	3,99±1,00	2,99±1,72
Weight uniformity diameter (µm)	763,53	756,23	751,04	748,04

granules was quite low (table 2). Granules with low water content have a good flowability because the moisture content is also low. High moisture in granules can increase the risk of sticky tablets on die and punch tablet compression machine. The flow time and the angle of repose of each formula showed excellent flow properties. Each formula produced granules with 26º - 28º angle of repose, indicated that the granules have excellent flow properties (Table 2). Compressibility test from all formulas was appropriate with the requirements needed, with the percent of compressibility value below 10%. This result which shows that the granule mass can be reduced in volume when given pressure (Hadisoewignyo and Fudholi 2013). From the results of flow time testing, the angle of repose and compressibility (table 2), it can be concluded that the granules of each formula have excellent flow properties. Good granular flow properties can affect the granule filling process from the hopper to the die which will affect the uniformity of the tablet weight.

In this study, the average values of particle size of the granules from F1 to F4 were 763.53 µm; 756.23 µm; 751.04 µm and 748.04 µm, respectively. According to Siregar (2010), the more massive and more spheric particles show better flow properties, compared with the smaller one. Particles with size >250 µm generally flow well, while the particle with the size <100 µm flow slower, because the effect of cohesion and adhesion that is greater in smaller particles which reduces the granular flow capability (Hadisoewignyo and Fudholi 2013).

3.4 Liquorice Extract Lozenges Evaluation

The tablet appearance of each formula did not show any differences, all formulas produced the same tablet that have round form, light brown coloured, sweet taste, flat and smooth surface. Taste is an essential factor in the preparation of the lozenges because it will be dissolved in the mouth for a long period (± 30 minutes), so it should produce a pleasant taste inside the mouth (Lachman *et al.*, 1986).

The weight uniformity test result (table 3) described that all formulas fulfilled the requirements set by Departemen Kesehatan Republik Indonesia (1979), that tablets with more than 300 mg are required not to be allowed more than 2 tablets that have a 5% weight deviation from the average weight of the tablet and there is no single tablet that has a 10% weight deviation of the average weight of the tablet. The excellent flow properties of the granules can produce uniform tablet weights. From the result of tablet size uniformity test, it can be stated that the tablets of each formula have met the requirements, the tablet diameter is no more than three times and not less than $1^1/_3$ of the tablet thickness (Departemen Kesehatan Republik Indonesia 1979). Good granular flow properties and punch stability produced a uniform tablet size during the tablet compression process.

The result of the hardness test (table 3) showed that there was an increase in the hardness of the tablet as the concentration of the binder was also

Table 3: Hardness, friability, and disintegration time evaluation of liquorice lozenges

Evaluation	Results				Requirement (Lachman *et al.* 1986)
	F1	F2	F3	F4	
Hardness (Kgf)	7,44±0,28	9,04±0,63	11,09±0,44	13,30±0,29	10-20 kgf
Friability (%)	5,76±0,39	3,04±0,63	1,13±0,16	0,45±0,03	0,8 – 1,0%
Disintegration Time (minute)	14,13±0,07	21,10±0,03	24,38±0,06	33,03±0,51	±30 menit

leveled up. The addition of avocado seed starch in the form of 10% mucilage by 15% (F3) and 20% (F4) as a binder produced lozenges that suitable with the hardness requirement of lozenges which is 10-20 kgf (Siregar 2010). The addition of the binder can affect the hardness of the tablet because the binder forms an internal matrix during the wet granulation process. The higher the binding concentration, the liquid bridges between solid particles that are formed are getting stronger. During the drying process, there is a crystallization of the binder, forming a solid bridge that gets stronger and increases the strength of the granule. It will produce harder tablet during the pressing process. In addition to the binder, the compression pressure provided during the pressing process can also affect the tablet hardness.

The result of the friability test (table 3) of the tablet found that F3 and F4 were close to the tablet friability requirement set by Lachman *et al.* (1986) which is 0.8-1%, while F1 and F2 were not suitable. Tablet friability test was carried out to determine the ability of the tablet to withstand the effects of mechanical shocks during the manufacturing, packing and distribution process (Lachman *et al.* 1986). The higher the binding concentration, the lower the friability percent of the tablet. The cohesive properties of the binder can reduce the friability of the tablet because the cohesiveness can bind small particles and form more extensive and stronger aggregates, so that during the compression process can produce a tablet that is strong and resistant to shock. In addition, the friability of the tablet can also be caused by the amount of water added during the granulation process. In F1, the amount of water added to form a banana breaking mass was much than F2, F3 and F4. The more amount of water added to the granule mass, the higher the tablet friability will be produced.

The disintegration time test was carried out using the disintegration tester. This measurement does not describe the actual condition in the mouth. Therefore, the purpose of this test was only to know the condition of the lozenges when in contact with water. The lozenges were designed to dissolve slowly in the mouth, so that they are not destroyed due to contact with water and are expected to dissolve in ± 30 minutes (Lachman *et al.*, 1986). From the result of the test, F4 was suitable with these requirements. Disintegration time is affected by the hardness of the tablet, the harder the tablet, the longer it will take to be broken.

4 CONCLUSION

Based on the results, this study showed that the lozenges that meet the requirements of hardness and disintegration time was F4, with the use of 20% avocado seed starch as a binder. Whereas in the friability test, F3 and F4 had closer friability requirements of common lozenges. It can be concluded that from higher avocado seed starch concentration used as a binder, it will also generate more hardness and disintegration time, and lower the friability as well.

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