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Edible Strip of Petai Peel (*Parkia speciosa* Hassk) as an Innovation for the Treatment of Diabetes Mellitus

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***Abstract*—Petai (Parkia speciosa Hassk.) or stink bean has been known as a folk medicine to treat inflammation, hypertension, kidney problems, and diabetes mellitus. Freeze-drying of petai peel contains phenol and flavonoid compounds. The edible strip is an innovative pharmaceutical dosage form that has a high level of effectiveness. The use of edible strips is increasingly leading to the exploration of herbal plants to increase the economic value of herbal medicine. This research aimed to determine the anti-diabetic effect of edible strip petai peel. This research is an experimental study — first, the extraction and screening of phytochemical content. The second step was the optimization of ESPP formula by using SLD and evaluation of its physical characteristics. The last step was comparing the anti-diabetic effect of IEPP with ESPP at 1 g/kg BW dose. The anti-diabetic effect was tested in alloxan-induced diabetes mellitus rats and analyzed statistically. The results showed that the IEPP contained flavonoid, saponin, and tannin compound. The HPMC K100M 40.8% and Propylene glycol 9.2% has pH 6, tensile strength 0.456±0.0005 N/m^2, and elasticity 80.184±0.003 MPa. The anti-diabetic effect of IEPP has no significantly different from the ESPP in 1 g/kg BW, respectively (56.72± 2.059)%, and (57.98± 3.095)%.**

Keywords—Edible Strip, Petai Peel, Innovation, Diabetes Mellitus

I. INTRODUCTION

Petai (*Parkia speciosa* Hassk.) or stink bean is a plant that is commonly found in Asian countries. The petai peel that was frozen dried and pollinated contains phenol and flavonoids compounds [1]. The extraction method impacts the phytochemical compound in plants. Maseration with n-hexan or ethyl acetate solvent showed that presence of flavonoids compound while using ethyl acetate or ethanol solvent produced alkaloid and triterpenoid compounds. Maseration with n-hexane, ethyl acetate or ethanol 70% solvents showed the presence of saponin, and tannin content [2].

In several studies, petai peel is known to have benefits in the field of medicine. Ethanol extract of petai peel has anti-inflammatory activity [3]. Meanwhile, methanol extract has antioxidant activity [4]. In Indonesia, people use petai peel stew to reduce blood glucose levels. In vivo, research has shown that 1 g/kg body weight of peel infusion can reduce blood glucose levels in alloxan-induced Wistar rats [5]. Studies were also carried out to assess the anti-diabetic potential by assaying the ability of the plant to inhibit pancreatic lipase and amylase activities. The percentage of inhibition at 500 µg/ml of the plant extracts were found to be 89.5% (for lipase) and 79.2% (for amylase).

This study was showed that petai peel has the potential to be developed as a therapy for diabetes mellitus [6].

The edible strip is an innovative drug preparation which made water-soluble polymers that use biodegradable materials. This pharmaceutical dosage form can enhance the functional properties of medicine [7]. The edible strips of petai peel that can increase the acceptability of petai when consumed. The edible strip is a new drug delivery system for the oral route, was developed based on transdermal patch technology. The delivery system consists of a very thin oral strip, placed on the patient's tongue or oral mucosal tissue. This dosage form increases the speed of hydration and solubility when placed on the tongue or oral cavity. The edible strips can also increase the onset of both local and systemic drugs [8]. Therefore, research needs to be conducted to test the edible strips of petai peel as an innovation in the treatment of diabetes mellitus.

II. MATERIAL AND METHOD

A. Procurement and Identification of plant material

Peel of plant was collected from farmer in the Boja, District of Kendal, in February. This plant was identified as *Parkia speciosa* Hassk (Family: Mimosaceae) by Dra. Endah Peniati, M.Si, Department of Biology, Universitas Negeri [1]Semarang (UNNES).

B. Preparation of extracts

Peel of petai was dried in shade. Dried peel was coarsely powdered, sieved (#100), and stored in an airtight container at room temperature. The dried powder was then extracted with water using the infundation method. The petai peel was infundated on 90^{0}C for 15 minutes, and then

the filtrate was evaporated by a waterbath is not more than 50^0C.

C. Phytochemical screening of extracts

The extracts was tested for phytochemical compounds trough chemical tests in tubes and thin-layer chromatography (TLC). TLC plates were made from silica gel F_{254} and carried out using tobacco extracts (alkaloids), katuk leaf extracts (flavonoids), aloe vera gel extracts (saponins), guava leaf extracts (tannins), and mahogany seed extracts (triterpenoids) as a comparative extract. Phytochemical screening was carried out to test the content of alkaloids, flavonoids, saponins, tannins, and triterpenoids.

D. Optimization of edible strip petai peel (ESPP) formula

The ESPP was made by optimizing from 8 formulas using the SLD in Design Expert 7.1.5 software. The formula was consist of petai peel extract (23.05%), film-forming (16.36%), methylparaben (0.2%), sodium saccharine (3%), corigen odoris (brown) (qs), and aquadest (until 100%). The composition of film-forming consisted of HPMC K100M and propylene glycol that has been optimized.

E. Physical characteristics test

The optimum formula that has been produced, then was tested for physical characteristics. There were organoleptic, homogeneity, pH, folding resistance, thickness, tensile strength, and elasticity. The real value of thickness, tensile strength and elasticity of optimum formula edible strip compared with the software value statistically.

F. Induction of experimental diabetes

Hyperglycemia rat was induced by injecting alloxan monohydrate at 135 mg/kg dose intraperitoneally. The rats were kept under observation and checked for blood glucose level before the injection. After 48 h, they were checked for blood glucose level using Glucometer strips. Only those rats which showed blood glucose levels >200 mg/dl, were separated and used for this study.

G. Experimental design

A Total of 20 diabetic rats were randomly divided into four groups with five rats each and treated once after 48 h alloxan injecting. The groups were group I: given only vehicle (sodium CMC 0,5%); group II: received glibenclamide 5 mg/kg body weight; group III: received IEPP at a dose 1 g/kg body weight; and group IV: received ESPP at a dose 1 g/kg body weight. The blood glucose levels were checked at 72, 120, 168, and 216 hours. The percentage decreases in the blood glucose levels of extract were monitored and compared with the glibenclamide group.

H. Statistical analysis

The Area Under Curve (AUC) values and the percentage of blood glucose levels in each group could be calculated. The results were analyzed statistically. $P<0.05$ were considered significant in relation to standard. All values are presented as mean$\pm$SE.

III. RESULTS AND DISCUSSION

Of 200 grams of petai peel powder was produced as much as 52.47 grams of a thick extract with a yield of 26.23%. The phytochemical screening was done by chemical tests in tubes and spotting in TLC. The eluent used has been chosen based on the optimization. The eluent was chloroform: methanol: water with a ratio of 2:2.5:0.5. The result of the screening shown in table I

TABLE I. PHYTOCHEMICAL SCREENING OF IEPP

Phytochemical compound	Chemical test in tubes	Spotting in TLC	Result
Alkaloids	No sedimen	No spot	(-)
Flavonoids	Orange	Fawn	(+)
Saponins	Formed foam	Brownish purple	(+)
Tannins	Greenish black	Black	(+)
Triterpenoids	Brown	Brownish purple	(-)

The result showed that IEPP contained flavonoids, saponins, and tannins. All of the compounds was polar. This was a concordance of the principal of extraction, which is like dissolve like. The compound that was extracted has chemical properties as a solvent that has been used. The infusion extract method used water as a solvent.

Optimization of formula was done on eight formulas using SLD. The difference of each formula was the composition of HPMC K100M and propylene glycol. Physical characteristics used as parameters in determining the optimum formula are thickness, tensile strength, and elasticity of the preparation. The results of the equation obtained shown in table II.

TABLE II. THE EQUATION RESULT FOR EACH PHYSICAL CHARACTERISTIC TEST BASED ON SLD

Parameter	The equation
Thickness (mm)	Y = 0.020(A) + 9.639E-0.03(B)
Tensile strength (N/m^2)	Y = 4.56(A) – 0.18(B)
Elasticity (MPa)	Y = 56.59(A) + 103.01(B)

On table II, it can be seen that the HPMC K100M has a greater influence on thickness and tensile strength than propylene glycol. However, HPMC K100M has a smaller effect on elasticity than propylene glycol. The optimal edible strip formula was shown by the film-forming composition with a ratio of HPMC K100M : Propylene glycol at 0.098: 0.902 or HPMC K100M at 40.8% and propylene glycol at 9.2%. The optimum formula was chosen has a desirability value of 0.936.

The weight of edible strips of petai peel extract was 275 mg. In the organoleptic test showed that the optimum formula has a thin sheet shape, brown in color, chocolate flavored, sweet taste, homogeneous, and has a pH of 6. Three of the physical characteristics test was done in the optimum formula. The result was shown that its thickness was 0.014$\pm$0.005, tensile strength was 0.456$\pm$0.005, and elasticity was 80.184$\pm$0.003. The result of prediction

software result and optimum formula on the physical characteristic parameter was no significance ($p>0.05$). The HPMC K100M exhibited good film-forming capacity with good tensile strength, disintegration time, and transparent film appearance [9]. As with propylene glycol, this material acts as a plasticizer. The propylene glycol provides a very flexible film layer [10]

Alloxan is one of the common diabetogenic agents often used to assess the anti-diabetic potential of both pure compounds and plant extracts in studies involving diabetes. Alloxan causes diabetes by a mechanism that involves partial degradation of the β cells of pancreatic islets and subsequent compromise in the quality and quantity of insulin produced by these cells [11].

Hypoglycemia is characteristic of experimental diabetes, and the phase has been noted to last for at least three hous or more [12], and is largely responsible for the mortality associated with alloxan-induced diabetes. The last phase of the blood glucose response to alloxan administration is touted to be a permanent diabetic hyperglycemic phase that takes place between 24 and 48 h after alloxan administration. Supposedly, there is complete degranulation and loss of structural integrity of the beta cells during this phase [12], [13].

The results revealed that alloxan monohidrat can induced hyperglycemia in rats at 135 mg/kg body weight within 48 hours ($p<0.05$). After 48 hours, the blood glucose level in IEPP, ESPP, sodium CMC 0.5% solution, and glibenclamide group experienced a different decrease. However, in the Sodium CMC 0.5% solution continued to increase until 216 hours.

The IEPP, ESPP, and glibenclamide groups had AUC values that were significantly different from the Sodium CMC 0.5%. The glibenclamide group had the lowest AUC, while the sodium CMC 0.5% group had the most significant values (table III).

TABLE III. ANOVA TEST OF AREA UNDER CURVE

Group	**Mean ± SE (mg.day/dL)**	**Significance of group-**			
		I	*II*	*III*	*IV*
Sodium CMC 0.5%	469.43 ± 9.88	-	0.000*	0.000*	0.000*
Glibenclamide	180.63 ± 4.01	0.000*	-	0.535	0.743
IEPP	201.50 ± 2.35	0.000*	0.535	-	0.984
ESPP	261.91 ± 2.40	0.000*	0.743	0.984	-

Glibenclamide is an oral anti-diabetic of sulfonylureas that works to reduce blood glucose levels by stimulating pancreatic β cells to release stored insulin [14]. Meanwhile, sodium CMC 0.5% was a derivate of cellulose that used as thicker, emulgator or suspending agent, and binder. It was inert so that it cannot decrease blood glucose level in rats [15].

The value of AUC in each groups was used to calculate the percentage of anti-diabetic activity. The percentage of anti-diabetic activity in glibenclamide, ESPP, and IEPP group were (61.32± 1.291)%, (56.72± 2.059)%, and (57.98± 3.095)%. The results showed that the three groups had no significant differences ($p> 0.05$).

TABLE IV. THE PERCENTAGE OF ANTI-DIABETIC ACTIVITY OF GLIBENCLAMIDE, IEPP, AND ESPP

Group	**Mean ± SE (%)**	**Significance**
Glibenclamide	61.320 ± 1.291	0.157
IEPP	56.722 ± 2.059	
ESPP	57.980 ± 3.095	

The One-Way ANOVA statistical showed that there were not significantly different ($p>0.05$). That means that the IEPP and ESPP have no significant effect on the percent decrease in blood glucose. The IEPP and ESPP have a percent decrease in blood glucose equivalent to glibenclamide. The edible strips dosage form of the optimum formula was not changed the effect of petai peel. So that, edible strips can become the innovation of diabetes mellitus therapy.

One of the possible mechanism of action is due to insulin secretion and improvement of glycogenesis process. The IEPP and ESPP contain flavonoids and tannin. Flavonoid has antioxidant activity that reduces oxidative stress and the amount of reactive oxygen species (ROS), which responsible in destruction of β pancreas cell [16]. Tannins affect astringent, which can form layers in the intestinal wall. This layer inhibit the increase of blood glucose level [17]. Based on that mechanism, the flavonoids and tannins are thought to play a role in the reduction of blood glucose in rats.

IV. CONCLUSION

The results showed that the extract of petai peel contains flavonoid, saponin, and tannin compound. The optimum formula was HPMC K100M 40.8% and Propylene glycol 9.2%. The optimum formula has pH 6, tensile strength 0.456±0.0005 N/m^2 and elasticity 80.184±0.003 MPa. The anti-diabetic effect of petai peel extract has no significantly different from the edible strip of petai peel in 1 g/kg BW, with the percentage decrease of blood glucose levels respectively (56.72± 2.059)%, and (57.98± 3.095)%.

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