

Note

Antiobesity Activity of Extracts from *Lagerstroemia speciosa* L. Leaves on Female KK-A^y Mice

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Summary Banaba in the Tagalog name, *Lagerstroemia speciosa* L., has been used as a folk medicine for a long time among diabetics in the Philippines. Extracts from banaba leaves have been reported to reduce diabetic symptoms in genetically diabetic mice (Type-II, KK-A^y). In the present study, female mice of the same strain showing remarkable body weight gain were used to examine the antiobesity effect of dietary banaba extract. Five-week-old female KK-A^y mice were fed a control diet or test diet containing 5% of a hot-water extract from banaba leaves instead of cellulose for 12 wk. Neither group showed any changes in diet intake during the experimental period. Body weight gain and parametrial adipose tissue weight were lowered significantly in the banaba diet group. Blood glucose levels were not suppressed in the banaba diet group, but hemoglobin A_{1c} was found to be suppressed at the end of the experiment. No effects on the serum lipids were observed, but the mice fed banaba extract showed a significant decrease, to 65% of the control level in total hepatic lipid contents. This decrease was due to a reduction in the accumulation of triglyceride. These results suggest that banaba had a beneficial effect on obese female KK-A^y mice.

Key Words *Lagerstroemia speciosa* L.; antiobesity, female KK-A^y mice, banaba

Banaba in the Tagalog name, *Lagerstroemia speciosa* L., is a very common tree in the Philippines (1). The effect on blood glucose levels due to a decoction of banaba leaves has already been investigated earlier (2,3), and the extract has been tested in diabetic model animals and found to reduce blood glucose both for mild alloxan-induced diabetes in albino rats (4) and genetically obese-diabetic mice, KK-A^y (5).

It is widely recognized in clinical medicine that obesity, hyperinsulinism and diabetes are closely related. A high blood glucose level accelerates lipogenesis and fat accumulation through hypersecretion of insulin and insulin requirement. If fat is over-accumulated in the body, physical activity is restricted and a burden is

placed on the internal organs. Various treatments are applied to prevent obesity, but there are many difficulties involved.

The present article describes the antiobesity actions of banaba in female KK-A^y mice.

Materials and methods

Materials. Banaba leaves, which were commercially obtained in the Philippines, were cut into small pieces. An extract was obtained by boiling in water for 30 min, after which it was centrifuged, filtrated through a 4- μ m filter, concentrated, freeze-dried and powdered.

Animals. Female KK-A^y mice (Clea Japan, Inc., Tokyo) were housed individually in plastic cages in an air-conditioned room ($23 \pm 2^\circ\text{C}$) with a 12-h light and dark cycle (lighting from 6:00 to 18:00). The mice were given water *ad libitum* and a basal diet for 1 wk.

Feeding experiments. Five-week-old female KK-A^y mice, weighing 24.1–28.4 g, were kept on an experimental diet for 12 wk. The diet composition, in grams per 100 g diet, was as follows: 24.5 casein; 46.5 α -corn starch; 6 corn oil; 7 mineral mixture (Clea Japan); 1 vitamin mixture (Clea Japan); and 5 cellulose powder. The diet of the banaba group contained 5% banaba hot-water extract instead of cellulose. Fasting plasma glucose levels were measured every 2 wk in the mice following 5 h of food deprivation. Blood samples were collected without anesthesia from the tail vein. Hemoglobin A_{1c} levels were determined at 8 wk and at the end of the experiment. The parametrial adipose tissue, kidney and liver were weighed, and the liver lipid composition was examined. The liver was subjected to lipid extraction with chloroform-methanol (2:1) (6), and total lipids were measured gravimetrically.

Analytical procedures. The concentrations of serum glucose, serum and hepatic total cholesterol, serum HDL-cholesterol and serum and hepatic triglyceride were measured using clinical-analysis kits (glucose C-II, cholesterol E, HDL-cholesterol and triglyceride E, Wako Pure Chemical Industries, Ltd., Osaka). Phospholipid in the liver was estimated by PL-test Wako. Hemoglobin A_{1c} was determined using a commercial kit (ROPET A_{1c}-S, Nihon-Chemical Co.).

Statistical analysis. The data reported are the means with their standard deviation, and statistical significance was determined between means by use of Student's unpaired *t*-test.

Results

Five-week-old female KK-A^y mice were kept on an experimental diet containing banaba for 12 wk. From 7 wk to the end of experiment, the body weight of mice in the banaba group was significantly lower compared to the control (Fig. 1). There was no difference in cumulative food intake between the control group (363 ± 95.9 g/12 wk, mean \pm SD) and banaba groups (367 ± 82.7 g/12 wk). Banaba group mice showed slightly increased blood glucose (under 5-h fasting conditions)

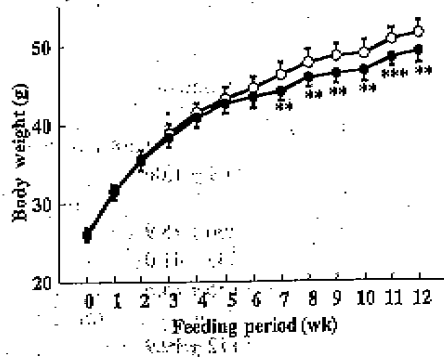


Fig. 1. Effect of banaba on body weight of KK-A^y mice. Five-week-old female KK-A^y mice were kept on the experimental diet for 12 wk. The data points represent mean \pm SD for 9 or 11 mice. Significantly different from control, ** p < 0.01; *** p < 0.001. ○, control; ●, banaba.

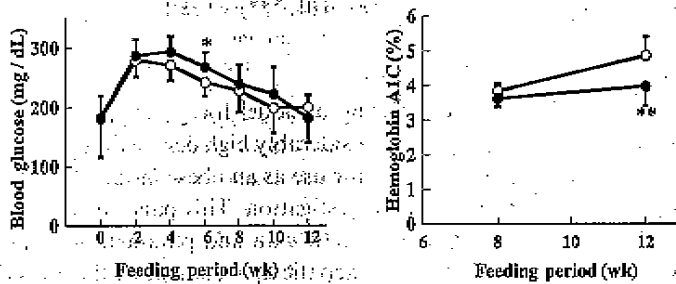


Fig. 2. Effect of banaba on blood glucose and hemoglobin A_{1c} of KK-A^y mice. Five-week-old female KK-A^y mice were kept on the experimental diet for 12 wk. The data points represent mean \pm SD for 9 or 11 mice. Significantly different from control, * p < 0.05; ** p < 0.01. ○, control; ●, banaba.

only 6 wk after feeding. Though hemoglobin A_{1c} was increased in the control group, the mice fed the banaba diet had levels significantly lower than the control group (Fig. 2). No changes in liver and kidney weight were observed between the control group (3.67 ± 0.41 and 0.90 ± 0.07 g/100 g of body weight, respectively) and banaba group (3.66 ± 0.33 and 0.93 ± 0.05 g/100 g of body weight, respectively). The parametrial adipose tissue weight was significantly lower in the banaba group as compared to the control group (Table 1). No significant changes in serum lipids were observed between the two groups. The control KK-A^y mice showed a high content of hepatic total lipid and triglyceride (Table 1), whereas in the banaba group mice, these levels were decreased.

Table 1. Effect of banaba on parametrial adipose tissue weight and lipid levels in serum and liver of KK-A^y mice.

		Control	Banaba
		(g/100 g of body weight)	
Adipose tissue weight		14.1 ± 1.06	12.9 ± 0.77**
		(mg/dL)	
Serum	Triglyceride	200 ± 75.9	244 ± 83.2
	Cholesterol	233 ± 41.0	223 ± 40.0
	HDL-cholesterol	135 ± 23.3	123 ± 15.5
		(mg/g liver)	
Liver	Total lipid	112 ± 19.9	72.7 ± 15.5***
	Triglyceride	63.9 ± 21.2	32.9 ± 14.3**
	Cholesterol	3.90 ± 0.67	4.08 ± 0.44
	Phospholipid	31.6 ± 1.89	32.5 ± 1.69

Five-week-old female KK-A^y mice were kept on the experimental diet for 12 wk.

Each value represents mean ± SD of 9–11 mice.

Significantly different from control, ** $p < 0.01$, *** $p < 0.001$.

Discussion

KK-A^y mice are recognized as being a model for genetically obese diabetes (7). The female KK-A^y mice showed a considerably high degree of obesity compared to the males (7, 8), indicating suitability for use as an obese model. For this reason, female KK-A^y mice were used in this investigation. This paper demonstrated that banaba significantly suppressed body weight gain and parametrial adipose tissue weight. Moreover, an inhibitory effect of hepatic lipid content by the banaba extract was observed. Hepatomegaly and an increase in hepatic lipid content are observed commonly in obese and diabetic animals (9). Also, KK-A^y mice have a high activity of lipogenesis in the liver (7). It was considered that banaba might inhibit lipogenesis in the liver, but there is still not enough evidence to clarify this matter.

Kakuda et al (5) have reported that the plasma glucose of male KK-A^y mice was gradually elevated with aging, and that banaba suppressed the rise in plasma glucose level from 2 wk after administration. Considering that female KK-A^y mice showed a lower blood glucose level than male KK-A^y mice (7), our results that there was no significant suppression in blood glucose level seem to be due to sexual difference. However, hemoglobin A_{1C} was decreased at the end of the experiment by banaba. The hemoglobin A_{1C} level may indeed be a valuable parameter for the evaluation of the adequacy of diabetic blood glucose control. Determinations of fasting or postprandial blood glucose levels reflect only an instant, while hemoglobin A_{1C} levels give time-averaged glucose levels over several preceding months (10). In this respect, the long-term feeding of banaba extract to female KK-A^y mice may also give a beneficial effect for diabetic symptoms.

In the present study, we confirmed the antiobesity effect of a hot-water extract

from banaba leaves as a dietary ingredient in female KK-A^y mice. Although some chemical components such as lageracetal, *n*-amylalcohol, ellagic acid, and three kinds of lagerstannins were identified in banaba leaves (11-14), it is not known whether components in the extract of banaba leaves cause this antiobesity effect.

REFERENCES

- 1) Garcia F. 1940. On the hypoglycemic effect of decoction of *Lagerstroemia speciosa* leaves (banaba) administered orally. *J Phil Med Assoc* 20: 395-402.
- 2) Garcia F. 1941. Distribution and deterioration of insulin-like principle in *Lagerstroemia speciosa* (banaba). *Acta Med Philippina* 3: 99-104.
- 3) Garcia F. 1956. Plantisul tablets in the treatment of diabetes mellitus. *J Phil Med Assoc* 31: 216-224.
- 4) Mishra Y, Khan MSY, Zafar R, Agarwal SS. 1990. Hypoglycaemic activity of leaves of *Lagerstroemia speciosa* (L) Pers. *Indian J Pharmacol* 22: 174-176.
- 5) Kakuda T, Sakane I, Takihara T, Ozaki Y, Takeuchi H, Kuroyanagi M. 1996. Hypoglycemic effect of extracts from *Lagerstroemia speciosa* L. leaves in genetically diabetic KK-A^y mice. *Biosci Biotech Biochem* 60: 204-208.
- 6) Folch J, Lees M, Sloane-Stanley GH. 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J Biol Chem* 226: 497-509.
- 7) Iwatsuka H, Shino A, Suzuoki Z. 1970. General survey of diabetic features of yellow KK mice. *Endocrinol Jpn* 17: 23-35.
- 8) Kimura M, Suzuki J, Amemiya K. 1979. A genetically diabetic model "KK-CA" mice" for a pharmacological assay. *Endocrinol Jpn* 26: 185-195.
- 9) Bray GA, York DA. 1971. Genetically transmitted obesity in rodents. *Physiol Rev* 51: 598-646.
- 10) Gabbay KH, Hasty K, Breslow JL, Ellison RC, Bunn HF, Gallop PM. 1977. Glycosylated hemoglobins and long-term blood glucose control in diabetes mellitus. *J Clin Endocrinol Metab* 44: 859-864.
- 11) Takahashi M, Osawa K, Sato T, Ueda J, Fujita Y, Yen K-Y, Lee T-C, Yang LL. 1973. The chemical structure of the new component "lageracetal" from the leaves of *Lagerstroemia speciosa* (L.) Pers. *Yakugaku Zasshi* 93: 861-863.
- 12) Osawa K, Ueda J, Takahashi M. 1974. The component of the plants of *Lagerstroemia* genus. II. Studies on the components of the leaves of *Lagerstroemia speciosa* (L.) Pers., *L. subcostata* Koehne., *L. indica* Linn., and *L. fauriei* Koehne. *Yakugaku Zasshi* 94: 271-273.
- 13) Takahashi M, Osawa K, Ueda J, Yamamoto F, Tsai TC. 1976. The components of the plants of *Lagerstroemia* genus. III. On the structure of the new tannin "Lagertannin" from the leaves of *Lagerstroemia speciosa* (L.) Pers. *Yakugaku Zasshi* 96: 984-987.
- 14) Tanaka T, Tong H-H, Xu Y-M, Ishimaru K, Nonaka G, Nishioka I. 1992. Tannins and related compounds. CXVII. Isolation and characterization of three new ellagitannins, lagerstannins A, B and C, having a gluconic acid core, from *Lagerstroemia speciosa* (L.) Pers. *Chem Pharm Bull* 40: 2975-2980.