[原著] Suppressive Effect of Kuroawabitake on Blood Sugar in Streptozotocin-Induced Diabetic Mice

Suppressive Effect of Kuroawabitake on Blood Sugar in Streptozotocin-Induced Diabetic Mice

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Abstract

Kuroawabitake(*Pleurotus abalonus*) is a kind of mushroom, originally found in Taiwan and Okinawa. It is currently considered as a dietary supplement if any favorable effects, for instance, lowering effect of blood sugar, could be observed, since some mushrooms have such effects. Five percent of kuroawabitake was mixed in a diet. Cellulose powder was used as a reference diet in place of kuroawabitake. These diets were given to diabetic mice induced by streptozotocin in order to measure which diet has a higher suppressive effect on blood sugar. The blood sugar increased about two times higher in two weeks in the diabetic mice than the mice fed cellulose or kuroawabitake diet. Kuroawabitake diet had a higher suppressive effect on blood sugar to some extent. Since cellulose itself is known to be liable to cause suppression of blood sugar, kuroawabitake would be more expected to be a hopeful functional food due to its higher suppressive effect.

Key words : blood sugar, dietary fiber, kuroawabitake, streptozotocin, diabetic mice

Introduction

Epidemiological evidence by Burkitt[1] and Trowell[2] that African and Asian regional people had lower incidence of heart failure, diabetes mellitus, hyperlipidemia and adult diseases than European and American people suggested that it would be due to high intake of dietary fiber. Since then many researches were carried out and it was now experimentally made clear that the lower incidence was attributed to dietary fiber in the food[3]. For the suppressive effect on blood sugar and cholesterol or insulin sparing effect, foods with high dietary fiber have been utilized for the prevention and cure of adult diseases[4].

Mushrooms contain some specific substances different from those in animal tissues and some of these have pharmacological and physiological effects. Kaneda et al. isolated a functional substance, eritadenin[5], from "shiitake" mushroom and reported that it reduces plasma cholesterol[6].

We used kuroawabitake(*Pleuropus abalonus*, Han, Chen et Cheng)[6] sold as a special food product of Okinawa on a commercial base to find its physiological function. First we studied its suppressive effect on blood sugar in diabetic mice induced by streptozotocin[7].

Methods

ICR male mice, 10 weeks old, average body weight 38g, were maintained on the diets as shown in Table 1. Kuroawabitake was used as the experimental diet. Cellulose powder was used as a reference substance, since it is most commonly used as a fiber source. The other components were the same both in the reference and experimental diet. The mice were divided into 6 groups, each group consisting of 6 to 8 mice. The first three groups were fed reference diet and the other three, the experimental diet. The diet and water were given ad libitum. The 1st and 4th group administered with the citrate buffer without streptozotocin for 5 days were used as the control groups of cellulose and kuroawabitake diet, respectively. The 2nd and 5th group were administered intraperitoneally with 50mg of streptozotocin (product of Wako Pure Chemicals Co. Ltd.) per kg of body weight for 5 consecutive days. Streptozotocin solution (5mg of streptozotocin per ml in 0.05M citrate buffer solution, pH4. 5) was administered within 5 minutes after preparation. About 80 $\mu\ell$ was administered per mouse. The 3rd and 6th group were also administered with the same amount of streptozotocin, maintained on the diet for one more week to observe time course variance of blood sugar in order to compare

Table 1 Diet composition (%)

	Reference[1] (Cellulose)	Experimental[1] (Kuroawabitake)
Casein[2]	25	25
α -Cornstarch[2]	39	39
Sucrose[2]	20	20
Cellulose powder[2]	5	0
Kuroawabitake[3]	0	5
Mineral mixture[4]	5	5
Vitamin mixture[5]	1	1
Oil[6]	5	5

[1]Reference and experimental diet contain 381kcal per 100g of diet.

[2]Casein, α – cornstarch, sucrose and cellulose powder were obtained from Oriental Yeast Co., Tokyo.

[3]Kuroawabitake powder was obtained from Okinawa developing center for functional food.

[4]Obtained from Oriental Yeast Co., Tokyo. The composition was as follows in mg/kg : $CaHPO_4 \cdot 2H_2O$, 7, 280; NaH_2PO_4; 4680, NaCl, 2,330; Ca- Lactate, 17,550; Fe-citrate, 1, 590; $MgSO_4$, 3, 590; $ZnCO_3$, 55; $MnSO_4 \cdot 4\text{-}6H_2O$, 60; $CuSO_4 \cdot 5H_2O$, 15; KI, 5.

[5]Obtained from Oriental Yeast Co., Tokyo. The composition was as follows in mg/kg : thiamine·HCl, 12; riboflavin, 40; pyridoxine·HCl, 8; Vitamin B_{12}, 0.005; ascorbic acid, 300; D-biotin, 0. 2; folic acid, 2; Ca-pantothenate, 50; γ -aminobenzoic acid, 50; niacin, 60; inositol, 60; choline chloride, 2,000; tocopheryl acetate, 50; menadione, 52 and in IU/kg retinyl acetate, 5, 000; ergocarciferol, 1,000.

[6]Soybean oil used was a product of Fuji Oil Co.

with the 2nd and 5th group.

The mice were anesthetized with ether from 11:30 a.m. to 12:00 a.m. and blood was taken by heart puncture. Blood sugar was measured by GOD method using glucose B-test Wako, a kit of Wako Pure Chemical Co.

Results

The average daily food intake was 19kcal before the administration of streptozotocin throughout the experimental period. Water intake and urine output remained unchanged. Five days after intraperitoneal administration of streptozotocin, there was a remarkable increase in food and water intake, and urine output. All groups administered with streptozotocin showed symptoms of diabetes mellitus[7]. Average energy intake from 8 to 14 days after streptozotocin administration was 28kcal for 2nd and 3rd group, and 29kcal for 5th and 6th group. When feeding was prolonged for 7 more days in 3rd and 6th group, the average energy intake increased to 44 kcal in both groups from 15 to 21 days.

The body weight, which was about 38g initially, increased in 5 days to 47.6 ± 2.5 and 43.9 ± 3.5g for 1st and 4th group, respectively. In the diabetic groups, body weight decreased to 33.8 ± 3.4 and 33.1 ± 2.5g for 2nd and 5th group, and 36.2 ± 3.6 and 36.2 ± 3.1g for 3rd and 6th group, respectively.

Table 2 shows the effect of kuroawabitake in time course on blood sugar of the diabetic mice in comparison with the control mice. The blood sugar level of the control groups, the mice fed cellulose or kuroawabitake diet for 5 days, were 184 ± 25 (1st group) and 204 ± 37mg/dl (4th group), respectively. In the mice administered with streptozotocin for 2 weeks, blood sugar levels were 419 ± 86 (2nd group) and 366 ± 66mg/dl (5th group) in cellulose and kuroawabitake diet group, respectively. When streptozotocin admininistration was prolonged for one more week, blood sugar levels were 453 ± 85 (3rd group) and 405 ± 67mg/dl (6th group), respectively.

The Figure shows the increment of blood

Table 2 Food intake, body weight and blood sugar levels in normal or streptozotocin-induced diabetic mice

	cellulose diet group			kuroawabitake diet group		
Group No	1	2	3	4	5	6
No of mice	6	8	7	7	8	7
Food intake[1]	19	19	19	19	19	19
(kcal/day)	—	28	28	—	29	29
	—	—	44	—	—	44
Body Weight (g)	47.6±2.5	33.8±3.4	36.2±3.6	43.9±3.5	33.8±3.4	36.2±3.1
STZ administration[2]	—	+	+	—	+	+
Time (days)[3]	5	14	21	5	14	21
Blood sugar (mg/dl)	184±25	419±86	453±85	204±37	366±66	405±67

[1] Average food intakes in 5 days for 1st and 4th group, 8 to 14 days for 2nd and 5th group, and 15 to 21 days for 3rd and 6th group, respectively.

[2] State of streptozotocin(STZ) administration. + ; administered and — ; non-administered

[3] Sacrificed time after feeding experimental diet.

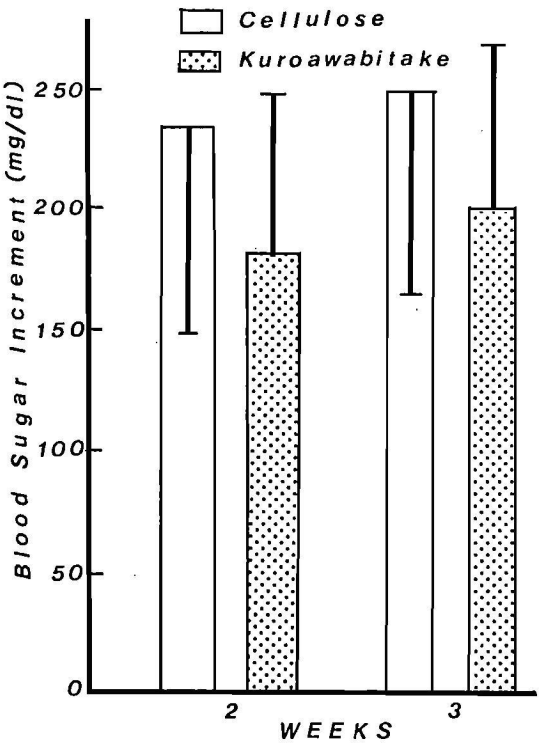

Fig. 1 Effect of kuroawabitake on blood sugar in streptozotocin-induced diabetic mice in 2 and 3 weeks. Blood sugar increment comparing to the control groups, i.e., non-streptozotocin administered mice fed cellulose or kuroawabitake diet, are shown in average value and standard deviation.

sugar in 2 and 3 weeks in the diabetic mice of the cellulose and kuroawabitake group. The cellulose diet group had increment of blood sugar by 235mg/dl in 2 weeks comparing to its control and 249mg/dl in 3 weeks, while the kuroawabitake diet group, by 182mg/dl in 2 weeks comparing to its control and 201mg/dl in 3 weeks, respectively. It showed the supressive effect of kuroawabitake on blood sugar was about 50mg/dl comparing to cellulose in 2 and 3 weeks, respectively, though there was statistically no significant difference by Student's *t*-test.

Discussion

From the food and water intake, urine output, body weight changes and blood sugar levels, we could conclude that the control groups, 1st and 4th group were non-diabetic, but the groups administered with streotozotocin, 2nd, 3rd, 5th and 6th group, had diabetic symptoms[7].

The number of mice with more than twice the value of blood sugar of the control group in 3 weeks after streptozotocin administration was 6 among 7 in the cellulose diet group and 4 among 7 in the kuroawabitake diet group, indicating less severity of the symptoms in the latter group.

By the blood sugar increment in 2 and 3 weeks in the diabetic mice as shown in the Figure, a greater suppressive effect on blood sugar was observed to some extent in kuroawabitake than cellulose. Considering that cellulose itself has the suppressive effect[3], however, kuroawabitake could be more useful as a functional food due to its higher suppressive effect than cellulose.

From the data that kuroawabitake had a suppressive effect on blood sugar, it may contribute to the prevention of adult diseases if taken frequently. Further studies ought to be carried out with a prolonged experimental period in order to evaluate more effects of kuroawabitake.

Cellulose was used since it is the commonest of the fiber groups, but hemicellulose, which occupies about 80% of dietary fibers in mushroom, might well be recommended as a fiber source instead of cellulose. Moreover animal models other than mice should be used for further study to evaluate the influence of kuroawabitake on blood sugar.

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