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6th International Conference on Sustainable Agriculture, Food and Energy IOP Conf. Series: Earth and Environmental Science 347 (2019) 012073 IOP Publishing doi:10.1088/1755-1315/347/1/012073 1 The potential of instant yellow cornmeal and tempe flour as glucose control on hyperglycemic conditions Susi Desminarti (a), Ermiati, and Rahzarni Department of Food Technology, Polytechnic of Agriculture Payakumbuh, Jln Raya Negara Km 07 Tanjung Pati, 26271, Indonesia . (a) Corresponding author: isusdesminarti@yahoo.com Abstract. The objective of this study to evaluate the glucose control potential of instant yellow cornmeal and tempe flour by using hyperglycemic mouse models.

In approaching this purpose, 24 male ddY mice were used and divided into 3 goups : group A (positive control group, hyperglycemic, 100 % standard feed), group B (treatment group, hyperglycemic, 60 % instant yellow cornmeal + 40 % instant tempe flour), and group C (negative control group, normal, 100 % standard feed). The evaluated parameters of body weight and blood glucose levels were measured during the 8-week period of the study. Results showed that group B (60 % instant yellow cornmeal + 40 % instant tempe flour ration) indicated the potential to control hyperglycemic conditions ($p<0.05$) and displayed higher levels of body weight (6.05 ± 6.08 grams, $p >0.05$) compared to groups A and C. 1. Introduction Nowadays, there is a dynamic and increasing market trend for functional foods and beverages. It is predicted that there will be an increase in market demand for functional foods in the future.

Functional foods have the potential to be developed into products that are beneficial for health. The food we consume daily plays a large role in fulfilling the energy and nutrients that our body requires in both macro and micro terms. However, along with the times there is also the rise of various types of degenerative diseases, where changes

in food consumption and lifestyle patterns are thought to be some of the causes. Several studies have shown that certain types of foods play a role in preventing and curing disease, which has led to the emergence of functional foods. Corn and tempe are food resources that have been utilized by the general population.

Corn is a low calorie food that is beneficial for people with hyperglycemia [1. Whereas tempe is known to be a traditional functional food of the Indonesian people. Tempe is relatively high in nutrients, affordable, and easy to produce. Processing tempe into instant tempe flour which will be further processed into functional foods is expected to have a higher use value and be beneficial for health. To date, there has been no data on the potential of instant yellow cornmeal and tempe flour on glucose control for hyperglycemic conditions.

The purpose of this study is to test the potential of instant yellow cornmeal and tempe flour as a control on glucose levels on the blood of hyperglycemic mouse models. 2. Materials and Methods 2.1. The production of instant tempe flour This study utilized the materials of instant yellow cornmeal and tempe flour which were specially made for the research. Yellow cornmeal was made by firstly coarsely grinding yellow corn kernels. 6th International Conference on Sustainable Agriculture, Food and Energy IOP Conf. Series: Earth and Environmental Science 347 (2019) 012073 IOP Publishing doi:10.1088/1755-1315/347/1/012073 2 Subsequently (before further grinding), the grits are soaked in cold water for 60 minutes. The husk and embryo are then separated from the endosperm (by collecting the parts floating on the water).

This is followed by the drying of the grits, grinding and sieving of the obtained cornmeal. Tempe was produced using the usual method carried out by tempe producers, with a fermentation period of 36 hours. The obtained tempe was of a bright yellow color bound with white mycelium fungi with a distinctive scent. The tempe was then steamed, grinded and gelatinized by adding water so that it turned into porridge-like consistency, which was subsequently formed into sheets and then frozen.

The frozen tempe sheets were then dried using a drum dryer until an instant tempe flour light yellow in color with a distinctive aroma and color is obtained. 2.2. Testing the potential of instant yellow cornmeal and tempe flour The experimental mice were divided into three groups, each treatment group comprised of eight mice at the age of eight weeks. The preparation stage of the mice included an adaptation period of ten days where they were given standard ration and water on an ad libitum basis.

The mice were reared in individual cages in a room maintained at a temperature of 25°C and 70% humidity and set to 12 hours of light and 12 hours of darkness. After the

10-day adaptation period, the mice of the hyperglycemic group were induced with alloxan (Sigma Chemical Co) in two stages of dosage which were alloxan 120 mg/kg body weight and alloxan 150 mg/kg body weight. Confirmation of hyperglycemia was performed on the third day after the induction of alloxan. Induction was successful if the blood glucose level > 250mg/dL[2].

The success rate of hyperglycemia through alloxan induction in this study ranged between 80 – 90 %. Blood was drawn from the coccigea vein of the mouse tails, and blood glucose levels were determined using the Accu-Check Advantage blood glucose system (strip method). The mice were then divided into three treatment groups: A (positive control, hyperglycemic, 100% standard ration), B (instant flour treatment of a mixture of 60% yellow cornmeal and 40% tempe flour, hyperglycemic), C (negative control, normal, 100% standard ration). Ration was given in powdered form at 10 grams/day. The standard ration given was ration normally used as feed for experimental mice. Rations were given to all experiment groups for a period of two months [3].

The body weight and blood glucose levels of the mice were measured every two weeks before their termination. 2.3. Experimental design and data analysis The experimental design used was the Completely Randomized Design (CRD). The obtained data was analysed using analysis of variance (ANOVA). If the treatment gave a significant influence, a Least Significant Difference (LSD) test at a significance rate of 5% is further performed to discover the difference between the treatments [4].

Data processing was conducted using the SPSS version 16 statistical software. 3. Results and Discussions 3.1. Change in Body Weight The clinical symptoms of hyperglycemia in humans and experimental animals include polydipsia, low increase of body weight, and polyuria as the effects of an indication of a metabolic disorder. A low increase of body weight is a sign of poor glucose metabolism [5]. The response data of body weight change and increase patterns during the 8-week intervention period is presented on Figure 1 and 2.

6th International Conference on Sustainable Agriculture, Food and Energy IOP Conf. Series: Earth and Environmental Science 347 (2019) 012073 IOP Publishing doi:10.1088/1755-1315/347/1/012073 3 00 10 20 30 40 50 H0 H 1 4 H 2 8 H 4 2 H 5 6 gram Day of Observation A B C 4.11 2.55 6.05 6.08 6.37 5.55 0 1 2 3 4 5 6 7 A B C gram Treatment Figure 1. Body weight change patterns during the 8-week intervention. A (hyperglycemic, standard ration), B (hyperglycemic, treatment ration of 60% instant cornmeal + 40% instant tempe flour), and C (normal, standard ration) Figure 2. Average body weight increase during 8-week intervention.

The different letters on the bar graph indicate the results of the significant difference test (P<0.05). A (hyperglycemic, standard ration), B (hyperglycemic, treatment ration of 60% instant cornmeal + 40% instant tempe flour), and C (normal, standard ration). Figure 2. shows that body weight increase in group B (hyperglycemic, treatment ration of 60% instant cornmeal + 40% instant tempe flour), and treatment C (normal, standard ration) show a relatively similar increase up to the end of the research, however the body weight increase of group A (hyperglycemic, 100% standard ration) showed a lower body weight increase during the research period. This means that it was able to improve body weight although still below that of the normal group.

Based on the ANOVA test (figure 2,), the increase of body weight during the 8-week experiment shows that the average body weight increase of treatments A, B and C had a non- significant difference (p<0.05). The average increase of body weight of group B were almost the same as group C and was larger compared to group A. There was an increasing pattern for the body weight increase of treatment group B up to the end of the observation period. It is highly probable that instant yellow cornmeal and tempe flour have the potential to improve glucose metabolic disorders on hyperglycemic conditions. 3.2.

Blood Glucose Levels Blood glucose levels are an important biological indicator for hyperglycemic conditions. Observation results of blood glucose level change patterns during the intervention can be viewed on Figure 3, while the average difference of blood glucose levels before and after the intervention can be found on Figure 3. 6th International Conference on Sustainable Agriculture, Food and Energy IOP Conf. Series: Earth and Environmental Science 347 (2019) 012073 IOP Publishing doi:10.1088/1755-1315/347/1/012073 4 0 200 400 600 H0 H 1 4 H 2 8 H 4 2 H 5 6 mg / d L Day of Observation A B C 48.29 84.35 (a) -183.29 42.93 (b) 3.29 13.62 -200.00 -175.00 -150.00 -125.00 -100.00 -75.00 -50.00 -25.00 0.00 25.00 50.00 75.00 mg / d L A, B, C (Treatment) There is a decreasing pattern of blood glucose in group B (hyperglycemic, treatment ration of 60% instant cornmeal + instant tempe flour), whereas group A (hyperglycemic, standard ration) that was given standard ration tended not to see an increase (Figure 3). Research results show that a mixture of 60% yellow cornmeal and 40% instant tempe flour can improve blood sugar levels on hyperglycemic conditions. Figure 3. Blood glucose change patterns during the 8-week intervention.

A (hyperglycemic, standard ration), B (hyperglycemic, treatment ration of 60% instant cornmeal + instant tem p e flour), and C (normal, standard ration). Figure 4. The average difference of blood glucose levels before and after the 8-week intervention. The different letters on the bar graph show a significant different result (P<0.05). A

(hyperglycemic, standard ration), B (hyperglycemic, treatment ration of 60% instant cornmeal + 40% instant tempe flour), and C (normal, standard ration). Based on the ANOVA test which was followed by the DNMRT difference test (Figure 4)at the end of the intervention period, the mice given the B ration treatment (60% instant cornmeal + 40% instant tempe flour) had the highest decrease of blood glucose levels and was significantly different ($p<0.05$) to treatments A (hyperglycemic, standard ration) and C (normal, standard ration). Whereas the decrease in glucose levels of treatment A were not significantly different to treatment C.

Observation results (Figure 4) show that group B (60% instant cornmeal + 40% instant tempe flour) had the largest difference between blood sugar levels at the beginning and at the end of research at 183 ± 42.93 mg/dL. In the case of group C (normal, 100% standard ration), although there was an increase of blood sugar at the end of intervention, the average rate was still considered normal, measuring between 105 – 133 mg/dL. The same applied to group A (hyperglycemic, 100% standard ration), which had a tendency to lack a decrease in glucose levels, where its levels were still quite high at 358 – 600 mg/dL.

The decrease of blood glucose in treatment group (B) which was given a mixture of instant yellow cornmeal and tempe flour was higher compared to the hyperglycemic group (A); this signifies that the mixture of yellow cornmeal and tempe flour have potential as a hypoglycemic agent. Several 6th International Conference on Sustainable Agriculture, Food and Energy IOP Conf. Series: Earth and Environmental Science 347 (2019) 012073 IOP Publishing doi:10.1088/1755-1315/347/1/012073 5 studies have indicated that isoflavones, genistein in particular, have a hypoglycemic effect on humans and animal model [6,7,8]. According to the research of [9], instant tempe flour contains genestein isoflavone levels of 5.41 mg/100g body weight and daidzein isoflavone levels of 37.82 mg/100g body weight. This study reveals that consuming 70 grams of tempe porridgecauses a lower increase of blood sugar levels compared to consuming 10 grams of pure glucose.

This phenomenon is very good for people with hyperglycemia and affirms the formation of resistant starch in these products (flour and porridge) due to its processing methods. 4. Conclusions A mixture of 60% instant yellow cornmeal and 40% instant tempe flour has the potential to control blood glucose which is significantly different to treatment A (positive control) and treatment C (negative control) ($p>0.05$). Body weight increase for treatment B was 6.05 ± 6.08 grams, while C was 6.37 ± 5.55 grams. These were higher compared to treatment A at 4.11 ± 2.55 grams.

Body weight change for treatment B (treatment group) was not significantly different to

group C (negative control) (p>0.05). The highest decrease of blood glucose levels was found in group B (a mixture of 60% instant yellow cornmeal and 40% instant tempe flour) and was significantly different (p<0.05%) to treatments A (positive control) and C (negative control). References [1] Suarni dan Muh. Yasin. 2011. Jagung sebagai Sumber Pangan Fungsional. Iptek Tanaman Pangan Vol. 6 No. 1 [2] Gutierrez RMP, Vargas RS. 2006. Evaluation of the wound healing properties of Acalyphalangiana in diabetic rats.

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Analisis dan peran tepung tempe instan sebagai kontrol glokosa, lipid, dan radikal bebas pada tikus model hiperglikemik. Disertasi. Institut Pertanian Bogor. Aknowledgement This research was funded by Penelitian Unggulan Strategis Nasional of the Ministry of Research, Technology and Higher Education of the Republic of Indonesia, with contract number 1280a/PL25/PL/2018

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