A Whey-Based, High-Protein Diet Promotes the Best Body Weight and Blood Sugar Control When Compared with Other Types of Diet in Male Sprague Dawley Rats

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Abstract

Experiments using different kinds of rat feed diet is being used in metabolic studies. Research using different diets on Sprague Dawley rats to see their effects on their physiology are well documented. Our aim is to identify the diet which promotes the best body weight and blood glucose control. Thirty-five Sprague Dawley rats were subdivided into five categories and were given five different diets for eight weeks. Namely the five diets are normal rat chow, high sugar, high starch, high protein (whey-based) and high fat rat feed formula. The rats were given specified diet pellets ad libitum with tap water. The result showed high protein diet significantly promotes body weight control and moderate blood sugar control among all the diet given. In conclusion, the preference of a high protein diet is commendable to ameliorate obesity and its negative effects, such as metabolic syndrome.

Keywords: *blood glucose, high-fat diet, body weight, high-protein diet*

1. Introduction

Metabolic syndrome is a cluster of signs and symptoms which is mainly caused by diet (Malik et al., 2010). Other than metabolic syndrome, there is also insulin resistance, obesity and other metabolic dysfunction which was contributed to a diet high in sugar (Nakagawa et al., 2006). Another group of diet which was found to cause this predicament is the high-fat diet (Haugaard et al., 2006) (Ali et al., 2016). Although diet has its defined role in the establishment of these diseases (Isganaitis & Lustig, 2005), sedentary lifestyles (Edwardson et al., 2012) coupled with low physical activity (He et al., 2014) are key contributors to developing insulin resistance and cardiovascular disease.

Both obesity and its correlated metabolic syndrome have developed into a worldwide health problem in these few years (Jauch-Chara & Oltmanns, 2014). High caloric surplus and rich macronutrient composition of food consumerism are key factors in the promotion of this obesity disaster. (Romieu et al., 2017).

Metabolic syndrome is a cluster of metabolic dysfunctions which presents upon an person an increased chance in getting cardiovascular disease when compared to people who does not suffer from metabolic syndrome (Ford 2004). Insulin resistance and central obesity are recognized as the main risk factors with several other denominators such as hypertension, triglyceride levels, High Density Lipoprotein blood levels and hyperglycemia. In clinical study in the USA, nearly 35% of US citizens, with 50% older than 60 years old, suffer from metabolic syndrome (Aguilar et. al., 2015). In Malaysia, obesity and its complications has been a serious health problem facing the Malaysian population for the last decade. By some estimations, the Malaysian population are overweight, on average, 40% above our ASEAN counterpart (Chan et. al., 2017). This is an unhealthy and unproductive position for our country to be in.

Recently there are a lot of trends promoting different fancy diets which claim to have the best effect on one's health. Our study aims to identify which diet promotes the best body weight control and blood glucose control in male Sprague Dawley rats.

2. Objectives

1) To identify what kind of diet promotes best body weight control.
2) To identify what kind of diet promotes best blood glucose control.

3. Methods & Materials

3.1 Thirty-five male, 8 weeks old Sprague Dawley rats were kept in a constant temperature room (22 degree Celsius) with alternating daylight and night cycle. Male rats were used to avoid the effect of the estrous cycle on the body weight and blood glucose monitoring. Sprague Dawley rats were chosen as they are widely used in metabolic research and are quite docile and easy to handle. The rats were kept in separate cages (two rats in one cage). After two weeks of familiarization period, they were subdivided into five groups with n=7. Each division were fed different rat feed formula each day for eight weeks and supplied with tap water ad libitum.

1) Control group – The rats were fed normal rat chow (Gold Coin). The nutrient breakdown is as follows: crude carbohydrates 64%, crude protein 21%, crude fibre 3%, crude fat 3%, ash 8%, calcium 0.8% and phosphorus 0.4%

2) High-sugar group – The rats were fed high sugar rat feed formula. The formula used was normal rat chow combined with 100% table sugar at a 50:50 ratio. Both the ingredients were blended in a blender and added water to form a dough. The dough was shaped into golf ball sizes and were dehydrated overnight in an oven at 60 degrees Celsius.

3) High-starch group – The rats were fed high starch rat feed formula. The formula used was normal rat chow combined with sticky rice flour (3 Gajah) at a 50:50 ratio. The ingredients were prepared as the high sugar feed.

4) High-protein group – The rats were fed high protein rat feed formula. The formula used was normal rat chow combined with whey protein (GNC 100% Whey Protein Advanced) at a 50:50 ratio. The ingredients were prepared as the high sugar feed.

5) High-fat group - The rats were fed high fat rat feed formula. The formula used was normal rat chow combined with palm oil (Sime Darby) at a 50:50 ratio. The ingredients were prepared as the high sugar feed.

All rat feed were filled to the brim into the food dispenser of each cage in the morning of the day and will be observed for any balance on the next morning. All rat feed were prepared the day before and dispensed from the oven the next morning ready to be consumed.

3.2 At the beginning of each week, for eight weeks, the rats were weighed and recorded. Blood glucose was taken by pricking the tip of the rats' tail with a sterile size 27-gauge needle under aseptic technique. Utilising a glucometer, their blood glucose level was determined, and the results was recorded for each rat.

3.3 The weight gain was analysed using SPSS software version 23 and the blood glucose data was analysed with Microsoft Excel.

3.4 All animal ethics practices are in compliance with the guidelines approved by the FOM IACUC University of Malaya (Ref: 2019-21114/UNIKL/R/KAMJ). Ethical considerations limit the research model in a human population, as it is deemed unacceptable to impose on a fellow human being the the possible hazardous effect of highly modified diet for a considerable amount of time. Clinical studies mainly include dietary studies under experimental conditions with strict ethical controls for a short time, usually for 10 days to two weeks.

4. Results and Discussion

4.1 Results

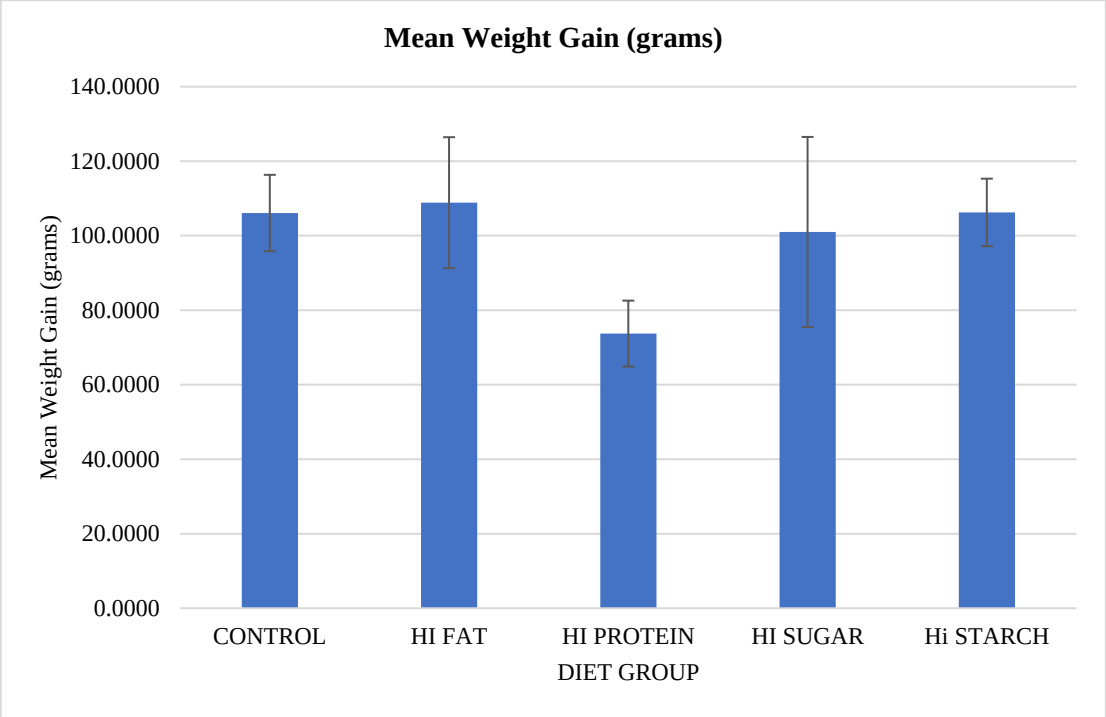

Figure 1 Shows the mean weight gain for different kind of diet groups after 8 weeks

Figure 1 Shows the mean weight gain for different kind of diet groups after 8 weeks. Lowest mean weight gain seen in the high-protein diet group. Mean weight gain for control group is 106.0857 gm, high-fat group 108.8571 gm, high-protein 73.7286 gm, high-sugar 101.0000 gm and hi-starch 106.2443 gm. There is significant difference in mean weight gain for high-protein group if compared to other groups with $p>0.01$. This shows that the high protein group registered the least weight gain among the groups.

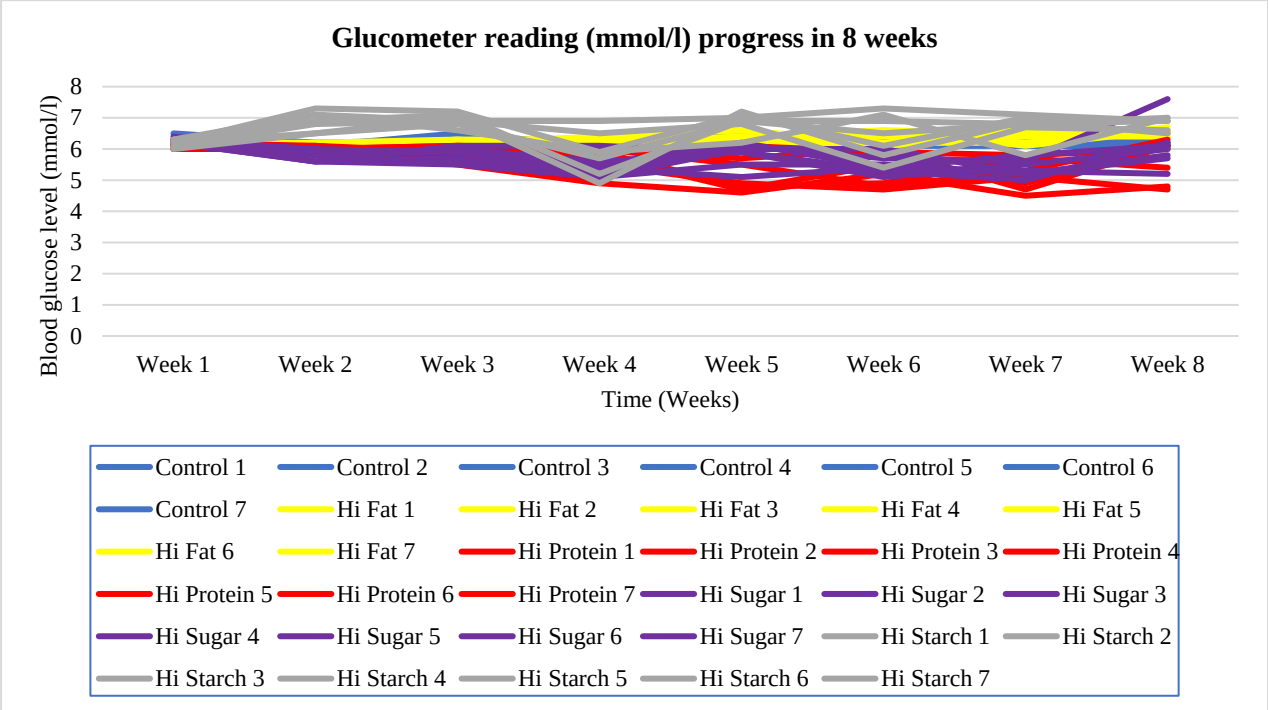

Figure 2 Shows the progress of glucometer reading in mmol/l of different kind of diet groups for 8 weeks period

Figure 2 Shows the progress of glucometer reading in mmol/l of different kind of diet groups for 8 weeks period. All groups registered a blood glucose level reading of 6 to 6.3 mmol/l at the beginning of the experiment. However, at the end of 8 weeks, high-protein diet group glucose is under 6 mmol/l and the high-starch group glucose is mainly above 6 mmol/l. Other diet groups blood glucose level range between 5 mmol/l and 7 mmol/l. The high-protein group (red lines) dominated the lower spectrum of the glucometer reading while the high-starch diet group (grey lines) dominates the upper spectrum. This result suggest that the high-protein group shows the best blood glucose level control. These results suggest that consumption of a high protein diet stabilizes blood glucose level and tends to lower blood glucose level in a eight week period.

4.2. Discussion

Our high-protein rat feed uses whey protein supplements used by bodybuilders locally and around the world (Pasiakos et al., 2015). Many Malaysians are beginning to be health conscious and are gym goers. These types of protein supplements are quite rampant in usage by average health-conscious people and are usually used as supplements in addition to their local staples.

Several diets for promotion of weight loss nowadays are focused on a high protein intake. In a report, 20 to 25 percent increase in lean protein energy source was shown to promote leaner body mass composition and reduce adipose cells in rats (Thonney & Ross, 1987). In several scientific reports, it was observed that a dimunition in total body weight occurs upon protein consumption higher than 50–55% (Peters & Harper, 1985; Harper & Peters, 1989; McArthur et al., 1993). The result shown in Figure 1 agrees with this conclusion. In our current study, the high protein diet contains 52% total protein.

A study using 50% total milk protein of the diet shows confirmation that the gut hormones are involved in the metabolism of different protein content of the diet (Jean et al., 2001). Another study concluded that rats administered with diet high in protein (50 percent protein) could prevent metabolic syndrome when set side by side to a diet with normal protein content (14% protein) (Lacroix et al., 2004). A clinical study reported that consumption of low-calorie diet comprising of largely whey protein for 45-days showed

significant weight loss, maintenance of muscle mass and positive changes in metabolic parameters (Basciani et. al., 2020). Dietary fats remain a strong factor in weight management, but the type and quantity of protein can also be important through its effects on food consumption (Rynders et. Al., 2018).

Figure 2 shows the high protein group blood glucose dominates the lower spectrum of the line chart. This observation suggests that protein has some glucose stabilizing properties. One research shows a high protein diet as a potential way to ameliorate hyperglycaemia (Gannon & Nuttall, 2004). This can empower patients to control their blood sugar without pharmacological intervention. A 2018 research concluded that a diet composed of low-carbohydrate and high-protein macronutrient ratio would bring a positive impact on the glucose level of diabetes mellitus type 2 patients (Huhmann et al., 2018). In one study, it was concluded that whey supplementation helped reduced post-prandial blood glucose level and help in suppressing the appetite (Mignone et. al., 2015). In particular, the apparent reduction in appetite associated with an increase in adiponectin in the high-protein whey diet can help stabilize body mass in chronic high-fat obesity induced by the nutritious food.

Another research documented that replacing carbohydrates with protein in a normal diet for the duration of 6 weeks decreases HbA1c of diabetes mellitus type 2 patients (Skytte et al., 2019) while one research done published in 2019 stated a diet high in protein content actually attenuates insulin concentrations in the plasma right after glucose was given (Higashida et al., 2019). Future research focusing on metabolic pathways should be done to elucidate these diets mechanism of action.

5. Conclusion

Our study suggests a whey-based, high protein diet promotes the best body weight control with moderate blood sugar control when compared with other type of diets. Abiding to the general health recommendations such as eating a balanced diet and moderate physical exercise, supplementation of a whey protein meal or meal replacement would be helpful in reducing weight and regulating blood glucose levels.

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