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Pumpkin Soygurt Improves Blood Glucose Homeostasis in Diabetes Mellitus Rats Model

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ABSTRACT

The study aimed to analyze the effect of pumpkin yogurt on insulin resistance in a rat model. The experiment employed 30 male Wistar rats divided into six groups: three control groups (healthy, negative, and positive) and three treatment groups (metformin+PS 1 mL, 1.5 mL, 2 mL). The experiments were conducted for four weeks. Blood glucose homeostasis was measured by fasting blood glucose, insulin, Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), and Quantitative Insulin-Sensitivity Check Index (QUICKI). Administrating a combination of metformin and pumpkin soygurt can control blood glucose homeostasis with an effective dose of 1 mL. Further research should be done on the hormone incretin, which plays a role in insulin secretion.

Keywords: fasting blood glucose, HOMA-IR, insulin, QUICKI, synbiotic

INTRODUCTION

Complementary therapy using functional food in the form of prebiotics and probiotics effectively controls blood glucose homeostasis. Pumpkin soygurt is a synbiotic that can increase the number and activity of beneficial microbes in the digestive tract. Soygurt is made from a combination of soybeans and pumpkins containing fructooligosaccharides, pectin, isoflavones, and fiber. This combination can control blood glucose homeostasis because this combination increases the abundance and activity of probiotic bacteria. Probiotic bacteria will use prebiotics as an energy source and produce metabolites in the form of short-chain fatty acid, which plays a role in blood glucose homeostasis and can be used for Diabetes Mellitus (DM) patients (Watson & Preedy 2019; Zhang *et al.* 2021). This study aims to analyze the effect of pumpkin soygurt on insulin resistance in a rat model of type 2 DM.

METHODS

The research was conducted at the Universitas Andalas biomedical laboratory from January to March 2023 with an experimental design and a pre-post test. This study employed 30 male Wistar rats divided into six groups. The healthy control group, negative control group, and Diabetes Mellitus (DM) group received metformin; the DM group received metformin and pumpkin soygurt at a dose of 1 mL; the DM group received metformin and pumpkin soygurt at a quantity of 1 mL, 1.5 mL, and 2 mL. Rats were conditioned with DM by induction of 230 mg/kgBB nicotinamide and 65 mg/kgBB Streptozotocin (STZ) intraperitoneally. Blood samples were taken through the orbital eye veins. Blood sample was centrifuged at 4,000 rpm for 20 minutes to obtain serum samples. Before sampling, the rats fasted for 12 hours. The data were analyzed using One-Way ANOVA. This research protocol received ethical approval from the Research Ethics Commission of the Faculty of Medicine, UNAND, with the number 1063/UN.16.2/KEP-KP/2022.

RESULTS AND DISCUSSION

As shown in Table 1, giving a combination of metformin and pumpkin soygurt can reduce Fasting Blood Glucose (FBG) (p=0.006), increase insulin (p=0.01), reduce HOMA-IR (p=0.023),

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Table 1. Effect of pumpkin soygurt on parameters related to diabetes mellitus

Parameter	Group	Mean±SD		
		FBG Pre (mg/dL)	FBG Post (mg/dL)	Δ FBG (mg/dL)
Fasting Bood Glucose (FGB)	KS	62.82±4.00	59.42±5.07	-3.40±1.91
	K-	274.44±71.45	241.64±120.62	-32.80±120.65
	K+	290.62±39.29	165.52±35.25	-125.10±36.23
	P1	269.100±32.70	94.33±36.70	-174.76±61.39
	P2	160.08±3.90	55.34±27.39	-104.74±28.98
	P3	164.37±35.24	49.87±16.53	-114.50±45.66
	p	<0.001*	<0.001*	0.006*
Parameter	Group	Mean±SD		
		INS Pre (mIU/L)	INS Post (mIU/L)	Δ INS (mIU/L)
Insulin (INS)	KS	2.46±0,67	4.66±1.64	2.19±0.99
	K-	1.17±0,34	0.49±0.32	-0.67±0,51
	K+	1.89±1,01	2,57±1.29	0.67±0.57
	P1	2.82±1,15	4.40±1.13	1.57±1.33
	P2	1,22±0,20	2.39±0.32	2.97±1.77
	P3	1.08±0,58	2.39±0.32	1.31±0.32
	p	0.004*	0.003*	0.023*
Parameter	Group	Mean±SD		
		HOMA-IR Pre	HOMA-IR Post	Δ HOMA-IR
HOMA-IR	KS	0.38±0.11	0.68±0.26	0.30±0.15
	K-	0.76±0.21	0.22±0.97	-0.53±0.19
	K+	1.33±0.71	0.98±0.36	-0.34±0.38
	P1	1.58±0.97	1.07±0.62	-0.51±0.89
	P2	0.48±0.09	0.49±0.24	0.12±0.16
	P3	0.41±0.16	0.30±0.13	-0.11±0.08
	p	0.007*	0.006*	0.055*
Categories	Group	Mean±SD		
		QUICK Pre	QUICK Post	Δ QUICK
QUICKI	KS	0.46±0.02	0.41±0.02	-0.04±0,01
	K-	0.40±0.01	0.51±0.04	0.11±0.05
	K+	0.37±0.03	0.38±0.02	0.01±0.01
	P1	0.37±0.04	0.39±0.04	0.01±0.04
	P2	0.43±0.01	0.44±0.03	0.01±0.02
	P3	0.45±0.04	0.48±0.04	0.03±0.02
	p	0.002*	<0.001*	<0.001*

KS: Healthy rats; K-: DM; K+: DM+metformin; P1: DM+metformin+1 mL pumpkin soygurt; P2: DM+metformin+1.5 mL pumpkin soygurt; P3: DM+metformin+2 mL of pumpkin soygurt

HOMA-AIR: Homeostatic Model Assessment for Insulin Resistance; QUICKI: Quantitative Insulin-Sensitivity Check Index; *Significant at p<0.05

and increase QUICKI index ($p<0.0001$). As a synbiotic, pumpkin soygurt contains Lactic Acid Bacteria (LAB), isoflavones, and polysaccharides that can help metformin control blood glucose homeostasis. Pumpkin Soygurt has 9.5×10^7 CFU/mL lactic acid bacteria; these bacteria control blood glucose by inhibiting the α-glucosidase enzyme, causing delays in digestion and absorption of carbohydrates (Farida *et al.* 2020). Isoflavones and phytoestrogens in soybeans also control the homeostasis of blood glucose levels by stimulating an increase in Glucagon-Like Peptide 1 (GLP-1) so that insulin increases and blood glucose levels decreases. Phytoestrogens can mediate estrogen receptor activities with their cross-functions on Peroxisome-Proliferator Activator Receptor γ (PPARγ), Peroxisome Proliferator Activated Receptor Alpha (PPARα), and Peroxisome Proliferator-Activated Receptor δ (PPARδ) to modulate insulin action and influence insulin signalling (Li *et al.* 2018). As a result, adiponectin production increases as an anti-inflammation. Adiponectin levels have a positive correlation with insulin sensitivity. As prebiotics, polysaccharides can improve insulin sensitivity and insulin resistance through the signalling pathway and activation of the Phosphatidylinositol 3-Kinase/Protein Kinase B (PI3K/Akt) pathway, which regulates the Extracellular Signal-Regulated Kinase/Jun N-Terminal Kinase/Mitogen-Activated Protein Kinase (ERK/JNK/MAPK) pathway, prevents β-cell apoptosis through regulation of mRNA expression in Bcl-2 and Bax against damage to β-cell cells due to STZ induction, and has intestinal microbiota regulatory effects (Liu *et al.* 2018). The process of fermenting polysaccharides by the gastrointestinal microbiota produces short-chain fatty acids, one of which is butyrate, which increases plasma insulin levels and insulin sensitivity by stimulating the hormone incretin in pancreatic β cells. Polysaccharides can bring an increase in the proliferation of *Akkermansia muciniphila* that is associated with insulin resistance.

CONCLUSION

Combining pumpkin soygurt and metformin can control glucose homeostasis and could be considered a complementary therapy for DM. Further research should investigate the hormone incretin, which plays a role in insulin secretion.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

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