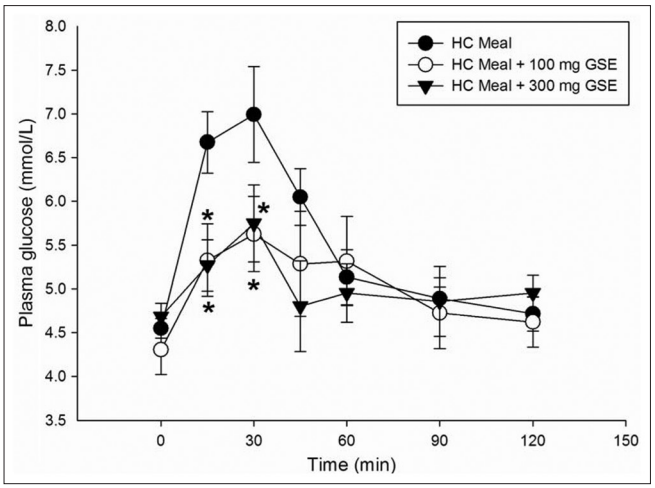

Figure 1: Plasma glucose concentration of high carbohydrate meal (•), HC meal + 100 mg GSE (◦), HC meal + 300 mg GSE (▼) in healthy participants (n=8). Values are means with standard error of the means represented by vertical bars. Mean value was significantly different from that of a HC meal: **P* < 0.05

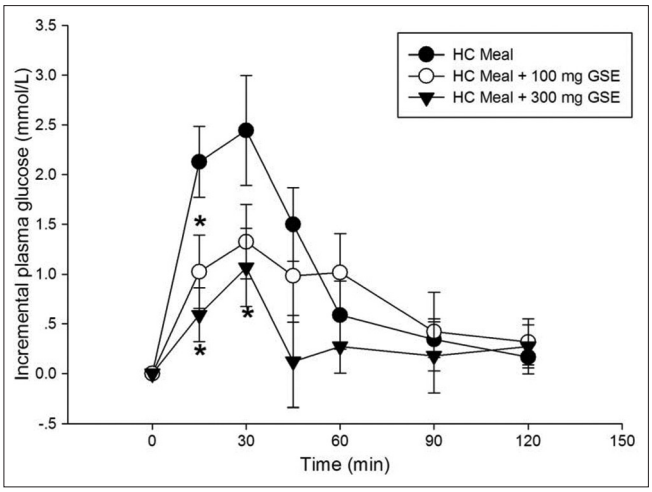

Figure 2: Incremental plasma glucose concentration of high carbohydrate meal (•), a HC meal + 100 mg GSE (◦), a HC meal + 300 mg GSE (▼) in healthy participants (n=8). Values are means with standard error of the means represented by vertical bars. Mean value was significantly different from that of a HC meal. **P* < 0.05

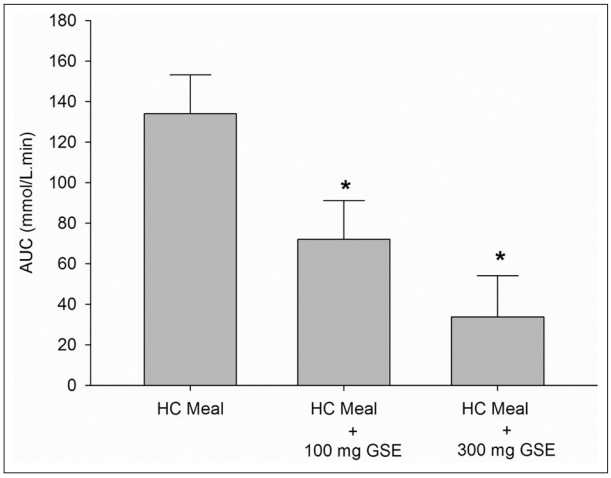

Figure 3: Area Under the Curve (AUC) of plasma glucose concentration (mmol/L) of high carbohydrate (HC) meal and HC meal + GSE (100 and 300 mg) in healthy participants (n=8). Value was significantly different from that of a HC meal: **P* < 0.05

DISCUSSION

This study is the first to demonstrate the effect of GSE on postprandial hyperglycemia in healthy participants. The primary outcome in this study was the effect of grape seed extract on postprandial glucose levels. We found that the consumption of high carbohydrate meal together with GSE (100 and 300 mg) reduces postprandial glucose in healthy subjects after 15 min administration. In addition, only GSE (300 mg) can suppress postprandial glucose level after at 0 min of consumption. The secondary outcome in this study was measured plasma glucose AUC (0-120 min) after intake of high carbohydrate meal. Our findings indicate that the AUCs were markedly lowered after ingestion of GSE (100 and 300 mg) together HC meal than after ingestion of HC meal. *One of the limitations* of this *study* was the narrow age range of the subjects. While the small sample size of the study limit the generalizability of the results, a larger trial involving a greater number of patients would be needed to validate the findings of this small study.

Previous research by our group has demonstrated that GSE markedly inhibits the intestinal α-glucosidases, pancreatic α-amylase activities *in vitro*. Interestingly, proanthocyanidins, a major component in GSE, have shown potent intestinal α-glucosidase and pancreatic α-amylase inhibitory activities.[18] It is possible that the reduced postprandial glycemia observed in the present study can be explained by the inhibitory activity of GSE proanthocyanidins against α-glucosidase and pancreatic α-amylase.

Much research has been focused on the control of postprandial glucose by the inhibition of pancreatic-amylase and the intestinal-glucosidases, the key enzymes of dietary carbohydrate digestion.[20] The slowing carbohydrate digestion and/or absorption is the most probable mechanisms underlying potential the attenuated postprandial hyperglycemia, as this condition is associated with the prevention of impaired glucose tolerance (pre-diabetes) and *a significant reduction in risk of developing* type 2 diabetes.[21,22] Recently, it has been reported that the treatment with an α-glucosidase inhibitor (acarbose) specifically delays postprandial hyperglycemia, reduced the risk of type 2 diabetes.[23] It is possible that consumption of GSE may prevent or delay developing type 2 diabetes in healthy people. The earlier evidence

reports that suppression of postprandial glucose may contribute to decreasing the level of HbA_{1c} resulting in a significant reduction in the incidence of chronic vascular complication such as macro- and micro vascular diseases.[24] Similarly, although this study included only healthy subjects, it may nevertheless apply to individuals with diabetes, as hyperglycemia is an independent predictor of future cardiovascular events in both healthy and diabetic individuals. Therefore, an intake of GSE might *help* people with type 2 diabetes mellitus control the postprandial hyperglycemia as thereby prevent the progression of diabetic complications.

Kar *et al* reported that after four weeks administration of GSE (600 mg/day) to diabetic patients, fructosamine was significantly decreased when compared to the basal level.[19] The fructosamine levels are used to access glycemic control since they can indicate the accumulation of early (Amadori) glycation products in diabetic patients. The reduction of fructosamine level can prevent the progression of diabetic complications. The recently published showed that GSE (200 mg/day) did not reduce plasma glucose and HbA_{1C} level in diabetic patients after two months of supplementation.[25] However, the effect of GSE on postprandial glucose and HbA_{1C} level in diabetic patients remains controversial. *Further studies* would be *needed* to determine the effect of GSE in diabetic subjects focusing on examining postprandial glucose and HbA_{1C} level which could yield important new insights into the preventive of diabetic complications.

CONCLUSION

GSE markedly reduces postprandial plasma glucose in healthy participants after consuming a high carbohydrate meal which suggests it may be a useful addition to other strategies aimed to prevent development of diabetes in the healthy population.

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