Effect of Sorghum Based Resistant Starch Rich Product Supplementation on Glycemia in Healthy Individuals

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Abstract: ***The use of resistance starch in processed foods is gaining attention due to its beneficial effect on the human health. Many companies are now manufacturing resistance starch for food fortification. As sorghum and millets are gaining popularity due to their health benefits resistant starch was developed within the grain and made in to rawa, which can be used for preparation of various breakfast and meal items. To test the efficacy on the selected physiological benefits, the RS food (rawa) was supplemented to healthy subjects in a single blind crossover study using rice rawa as control. The subjects served as their own controls. The results of study revealed that there was no significant difference among the subjects in fasting as well as PP (Postprandial) glucose levels (P>0.01). The mean fasting and PP was 82.3 and 98.7 respectively after RS food supplementation. Though, statistically not significant slightly higher mean PP glucose was observed in males (98.7mg/dl) than in females (100.42mg/dl).***

Keywords: Sorghum, gylcemia

1. Introduction

The human diet has consisted of whole grains for many thousands of years. However, recently a shift from whole grain to refined grains has occurred in the human diet . The grind mills that were used previously to grind the grain did not separate the bran and germ from the endosperm. With the introduction of the roller mill, a machine that more efficiently separated the bran and germ from the endosperm, refined grain entered the human diet. Refined grain contains much more starch and fewer phytochemicals and vitamins than whole grains .However, in the 1970's consumption of whole grain increased due to the 'fiber hypothesis' which suggested that whole foods that provide fiber result in significant health benefits. Today, whole grain consumption has been associated with a decreased incidence of cancer, cardiovascular disease (CVD), diabetes and obesity. In fact, the consumption of whole grains is associated with a decrease in the incidence of cardiovascular events. The 2006 diet and lifestyle recommendations by the American Heart Association states that a diet rich in whole grains can decrease the risk of CVD and that half of all grain consumption should consist of whole grains. The cholesterol lowering and improved glucose response is associated with the effects of soluble fiber, although insoluble fiber is well known for its effects on bowel stimulation.

Sorghum bicolor L. Monech is the fifth most important cereal crop worldwide, both in terms of planted area and metric tons harvested . Sorghum flour is rich in phytochemical components, including tannins, phenolic acids, anthocyanins, phytosterols, and policosanols, with a potential to benefit human health . These phytochemicals have gained increased interest due to their antioxidant activities cholesterol-lowering properties, and anticarcinogenic and antidiabetic effects. Chung et al. demonstrated that a sorghum extract (SE) reduces serum fasting cholesterol and glucose levels, but no previous reports have investigated the effects of sorghum or a SE on changes in adipocytokine levels or on the glucose-lowering pathway

2. Methodology

A total of 14 healthy subjects (male -7, female -7) with age group ranging from 18-22 yrs were selected for the study. Single blinded cross over design was used, where the subjects were unaware about the food. The subjects were recruited for the study after taking written consents from them. The mean base line glucose, lipid levels and BMI of the subjects were 83.23, 109.21, 103.44, 108, 40.46, 73.72 mg/dl and 20.7 respectively. Four types of most commonly used recipes were prepared using 50 g (18g of resistant starch) of either designer *rawa*or control *rawa*(5 g of Resistant starch) using standards procedures and supplemented for 21 days and after one week wash out period control food was supplemented for 21 days, during the study period the subjects were allowed to consume their regular foods.

3. Results and Discussion

Effect of RS rich food *vs* normal food on blood glucose levels

The mean fasting and PP glucose levels calculated using general linear model after supplementation of RS food and normal food is presented in Table 1. There was no significant difference among the subjects in fasting as well as PP glucose levels (P>0.01). The mean fasting and PP was 82.3 and 98.7 respectively after RS food supplementation. Though, statistically not significant slightly higher mean PP glucose was observed in males (98.7mg/dl) than in females (100.42mg/dl). The mean fasting and PP glucose levels, after supplementation of control food were 84.6mg/dl and

106.5mg/dl respectively. Among the subjects there was no significant difference in the fasting and PP glucose levels.

Table 1: Mean glucose levels of the subjects after RS food and Normal food Supplementation

	RS Food		Control Food	
Subjects	Fasting Glucose (mg/dl)	PP Glucose (mg/dl)	Fasting Glucose (mg/dl)	PP Glucose (mg/dl)
Overall (n=14)	82.3(1.0)	98.7(1.5)	84.64(1.3)	106.5(1.2)
Male (n=7)	82.57(1.05)	97.0(1.5)	84.7(1.8)	106.7(0.79)
Female (n=7)	82.14(1.05)	100.42(1.5)	84.7(1.8)	106.4(1.79)
	N.S	N.S	N.S	N.S

Figures in parenthesis are SE, *P<0.05, N.S- Non significant, PP-postprandial

The results of the paired t-test performed to find out the differences in the fasting, PP before and after supplementation of RS rich diet and normal diet is presented in Table2.There was no significant difference in the fasting glucose levels before and after supplementation of either RS rich food or normal food. However there was a higher mean (0.92) difference with the RS rich food supplementation than that of normal food and more difference was observed among females than males. In contrast to the fasting glucose levels, there was a significant effect on the postprandial (PP) glucose levels when supplemented with RS rich sorghum food (P<0.01) and control food (P<0.05), higher difference was observed in females than males in the change from baseline PP when RS rich food was supplemented (F-10.8, M-10.1). There was 9.6% reduction in PP glucose base line to RS food supplementation, slightly higher reduction was observed in females (9.7) than in males (9.5). With regard to RS food and Control food PP the shift was 8.0 % in general, higher reduction was observed in males (10.1%) than in females (6.0%).

Table 2: Mean differences, SD and SE of blood glucose levels of before and after supplementation of RS rich food *vs* control food

Details of pairing		Mean difference	SD	Sig. (2-tailed)
BF - RSF	Overall	0.92	4	0.4
	Female	1.71	2.5	0.12
	Male	0.14	5.17	0.94
BPP - RSPP	Overall	10.5	3.83	0.00**
	Female	10.85	4.25	0.00*
	Male	10.14	3.67	0.00*
BF - CF	Overall	1.35	6.52	0.45
	Female	-0.85	6.61	0.744
	Male	-1.85	6.91	0.504
BPP - CPP	Overall	2.64	3.02	0.00*
	Female	4.85	2.6	.003*
	Male	0.42	1.27	0.407
RSF - CF	Overall	-2.28	5.38	0.136
	Female	-2.57	6.24	0.318
	Male	-2	4.86	0.318
RSPP - CPP	Overall	-7.85	4.43	0.000*
	Female	-6	3.74	0.005*
	Male	-9.71	4.53	0.001*

RSF- Resistant starch food fasting, BF – Baseline fasting, CF- Control food fasting, BPP- Baseline postprandial, RSPP- Resistant starch food postprandial, BPP- Baseline postprandial, CPP- Control food postprandial. * Significant (P< 0.05) ** Significant (P<0.01)

The control food also contained 10% of RS, (not RS 3) this might have contributed to this lowering effect on PP levels. Further it might also be due to the crossover effect of RS food supplementation despite of 7 days washing period

A significant difference (P<0.05) was also observed in the PP levels of RS food and normal food in both females and males. The results reemphasize the knowledge that normal starch is digested immediately and can cause major spikes in postprandial blood glucose. Slower rates of starch absorption from RS may be a useful tool for reducing postprandial glycemia and insulinemia by releasing glucose over a longer period and thereby providing better control of blood glucose and insulin that would be helpful for individuals with diabetes. Similar results were reported by many investigators (Grossman, 1986., Leathwood and Pollet, 1988., Holt *et al.*, 1992., Doweet *al.*, 1993., Moffett *et al.*, 1993 and Raben *et al.*, 1994) that resistant starch consumption effects the postprandial glucose levels in the blood will thus be lower than after consumption of digestible carbohydrates.

Though the control food did not contain RS 3, still it has 10% of other RS types along with the 3.9% dietary fibre which might have contributed for the reduction of PP in the subjects. RS and soluble fiber are slow to digest, with RS digestion usually occurring 5- 7 hours after consumption, and result in slower, more controlled glycemic response and lowered postprandial insulinemia and potentially increasing satiety (Jenkins *et al*., 1987; Raben *et al*., 1994). Therefore, RS consumption represents a lower net energy intake compared with an identical amount of digestible starch. This might be of benefit for the obese.

Furthermore, because of its indigestible character, RS consumption result in lower postprandial glucose and insulin responses compared to digestible starch consumption. Resistant starches affect postprandial glucose levels through three common mechanisms: inhibiting α-amylase from digesting starch into glucose, increasing the viscosity of chyme in the small intestine which slows the rate of glucose uptake, and binding glucose which prevents its diffusion into the mucosal cells. These mechanisms were determined through in vitro comparison analysis of glucose diffusion, absorption/binding, and α-amylase activity in glucose-fiber complexes of RS, water insoluble, and water soluble fibers (Ou *et al*., 2001). When a test meal of mixed macronutrients containing 50g of RS3 was compared with 50g of fully digestible cornstarch in 8 subjects, the retrograded amylose meal lowered AUC in both glucose and insulin during absorptive state. Bloods samples were taken up to 27 hours after ingestion, but no difference was found between glucose and insulin in post absorptive state, suggesting acute effects for application and benefits of RS3 consumption (Achnor*et al*., 1997). However Kendall *et al.* (2010) reported that the resistant starch RS3 (from5–25 g in a meal) has been shown to have no effect on incremental area under the curve (iAUC) for glucose or insulin. However, there was a decrease of the incremental blood glucose and insulin levels after a meal containing 25 g RS at 90 and 120 minutes after the meal (p¼0.004 and 0.001 for glucose, p¼0.043 and p¼0.042 for insulin, respectively). In the present study supplementation of RS food has beneficial effect on PP glucose than fasting glucose; however continued usage of this food in different forms might contribute for the beneficial effects on the glycaemia. The mean fasting and PP glucose levels, after supplementation of control food were 84.6mg/dl and 106.5mg/dl respectively. Among the subjects there was no significant difference in the fasting and PP glucose levels.

4. Conclusion

There was a significant effect on the postprandial (PP) glucose levels when supplemented with RS rich sorghum food ($P<0.01$) and control food ($P<0.05$).

Fasting glucose reduced by 1.08% and 2.8% and from base line to RS food and from RS food to control food supplementation respectively, while from base line to control food the reduction was 1.68%.The pp glucose was reduced by 9.61% and 7.79% from base line to RS food and from RS food to control food supplementation respectively, while from base line to control food the reduction was only 2.4%. Higher difference was observed in females than in males in the change from baseline PP when RS rich food was supplemented (F-10.8, M-10.1).

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