

Exploring the therapeutic potential and bio-evaluation of muesli (*Chlorophytum borivillianum*) for the management of postprandial glucose management in healthy and diabetic female subjects

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Abstract: Muesli and cereal based breakfast contain generous amounts of fiber that are helpful in the management of blood glucose levels. Muesli contains β -glucans that ensure gradual rise in blood glucose levels. Muesli also limits the absorption of glucose by making it unavailable. This study explored the effect of muesli in the management of postprandial blood glucose levels. 15 healthy and 15 diabetic females were offered muesli meal after 8h fasting. Fasting blood glucose levels and blood glucose level 30 and 60 minutes after meal were measured. Results of study showed that muesli brought a gradual rise in blood sugar level. Healthy females showed fasting sugar (92.17 ± 11.27), after 30 minutes (110.87 ± 13.85) and after 60 minutes (114.25 ± 15.67) while diabetic females showed fasting sugar (113.25 ± 10.87), after 30 minutes (117.83 ± 18.74) and after 60 minutes (118.26 ± 17.85). The nutritional profile of muesli showed that it contained 202 kcal of energy, 32.7g of carbohydrates, 9g of fiber, 12.4g of protein and 2.5g of fats. It also contained 5.1g of β -glucans. Muesli found to be effective in the management of postprandial blood glucose levels in healthy and diabetic populations.

Keywords: Muesli, nutrition profile, carbohydrates, proteins, fats, β -glucans, fiber, energy.

INTRODUCTION

Rise in blood glucose level is observed when meals are consumed. This rise can be slow or fast depending upon the nature of the food consumed. Food's ability to elevate blood glucose levels is known as Glycemic Index (GI) of food. Foods which have high glycemic index of food raise the blood glucose faster than those with low glycemic index foods. High glycemic index foods are detrimental to the health and can lead to the onset of metabolic diseases (Rai *et al.*, 2019). Low glycemic index foods are more health friendly and promote gradual rise in blood glucose level. It reduces the glycosylated hemoglobin by 9% i.e., increase the insulin sensitivity (Hessel *et al.*, 2021). There exists a strong association between GI of food postprandial blood glucose levels. Low glycemic index foods bring gradual rise in postprandial blood glucose level (Kurotobi *et al.*, 2010). Low glycemic index foods are also preferred as a therapy for diabetics (Mrázková *et al.*, 2021). Muesli in this regard, an important product that ensures gradual rise in blood glucose level after a meal. Muesli is enriched with oat β -glucans. These β -glucans

are responsible for gradual rise in postprandial blood glucose levels and help in lowering the cholesterol levels in the body. The mechanism of β -glucans is not clear yet. It is hypothesized that β -glucans mount up the viscosity in the lower gastrointestinal track i.e., intestine and slows down the absorption of food and glucose from the intestine (Curtain & Grafenauer, 2019). However, another hypothesis states that β -glucans delays the gastric emptying by increasing the viscosity of fiber in the intestine (Hlebowicz *et al.*, 2008). Limited reaches are conducted to see how actually β -glucans play their role in gradual rise in postprandial glucose level and can be a therapy for diabetic too (Quatela *et al.*, 2018). The novelty of this research about was the chemical characterization of the muesli in which we analyzed the nutritional profile of the muesli and the phytochemical profile along with some minerals on which bases thus research of muesli on the blood glucose level was carried out. The presence of active metabolites in the form of β -glucan in muesli incorporate strong mechanism of action against the management of blood glucose level in the body. This study was designed to investigate the effect of muesli meal on postprandial blood glucose levels in healthy and diabetics. Blood glucose levels were

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measured in fasting and 30 and 60 minutes after meal consumption.

MATERIALS AND METHODS

Collection of muesli

Muesli (*Chlorophytum borivilianum*) and sugar free plain yogurt were purchased from Imtiaz Supermarket and stored in a refrigerator.

Chemical characterization of muesli

Nutritional profile of muesli and yogurt

Muesli and yogurt meal was analyzed for the following nutritional profile including total energy, carbohydrates, protein, fiber and fat from the labels of the products.

Investigation effect of muesli on postprandial blood glucose level

Selection of subjects

Healthy and diabetic female subjects, 15 each of age 18-45 years were randomly selected at a private software company.

Exclusion criteria

Male participants and other complications like ischemic heart disease were not included in the study. Pregnant and lactating women were also not included.

Inclusion criteria

All subjects went through blood biochemical analysis by checking their random and fasting blood sugar.

Study duration and study design

The study was conducted on a single day (October 17, 2022).

Treatment groups and treatment plan

Subjects were divided into two groups of in each group. One group was only of females and other of only male participant. Participants were given 200g yogurt and 24g muesli without any sugar added overnight fasting (8h).

Postprandial blood glucose level

Fasting blood sugar level before meal and postprandial blood glucose level 30 and 60 minutes after meal were measured using ACCU-check meter Roche.

Ethical approval

Ethical approval was taken from the biosafety committee, Agriculture University, Faisalabad vide Ref#Ec-342.

STATISTICAL ANALYSIS

Descriptive statistical analysis using the independent sample t-test under a Completely Randomized Design (CRD) was carried out to investigate the level of significance ($p < 0.05$). Results are shown are mean \pm S.D.

All statistical analyses are done with IBM SPSS Statistics 20 (Heeren & D'Agostino, 1987).

RESULTS

This research study was designed to determine nutritional profile and changes in postprandial blood glucose levels after consuming muesli meal. Fasting blood sugar level, and blood sugar level 30 minutes and 60 minutes after meal were measured.

Nutrition composition of muesli meal

The nutritional profile of muesli showed that it contains 202 kcal of energy, 32.7g of carbohydrates, 9g of fiber, 12.4g of protein and 2.5g of fats. It also contained 5.1g of β -glucans.

Table 1: Treatment Groups and Treatment Plan

Treatment Groups	Title	Treatment
F	15 healthy female subjects	224 g of muesli meal in sugar free and fat free yogurt
M	15 diabetic female subjects	224 g of muesli meal in sugar free and fat free yogurt

Table 2: Mean \pm S.D for Nutritional Profile and Calories of Muesli Meal

Components	Amount with Units
Energy (Kcal)	202kcal
Carbohydrates	32.7g
Protein	12.4g
Fats	2.5g
Fiber	9g
β -glucans	5.1g

Investigating the effect of muesli on postprandial blood glucose level

Blood glucose levels of participants were measured after fasting (8h), 30 and 60minute after meal after they were given 224 grams of muesli meal containing 200 grams fat and sugar free yogurt and 24 grams of commercially available muesli.

Fasting and postprandial blood sugar level of healthy and diabetic female subjects

Results of study showed that muesli brought a gradual rise in blood sugar level. Healthy females showed fasting sugar (92.17 ± 11.27), after 30 minutes (110.87 ± 13.85) and after 60 minutes (114.25 ± 15.67) while diabetic females showed fasting sugar (113.25 ± 10.87), after 30 minutes (117.83 ± 18.74) and after 60 minutes (118.26 ± 17.85). Results were depicted in table 3.

Table 3: Mean \pm S.D for fasting and postprandial blood sugar level of healthy and diabetic female subjects in g/dl

Duration	Fasting blood sugar	Post-meal (30 minutes)	Post-meal (60 minutes)	p-value
(HF)	92.17 \pm 11.27	110.87 \pm 13.85	114.25 \pm 15.67	p<0.05
(DF)	113.25 \pm 10.87	117.83 \pm 18.74	118.26 \pm 17.85	p<0.05

Healthy female: HF, Diabetic female: DF; significance (p<0.05)

DISCUSSIONS

Effects of muesli on postprandial blood glucose levels were measured. Study reported the gradual rise in blood glucose levels in healthy and diabetic females. Muesli meal contained a generous amount of fiber. Fiber had a crucial role in lowering the postprandial blood glucose levels. The mechanism involved was that dietary fiber increases the viscosity in the intestine, delays the digestion and absorption of glucose and carbohydrates in the intestine. Dietary fiber bonded the glucose and decreases the concentration of available glucose (Apergi *et al.*, 2022). Another action that was performed by dietary fiber is that it reduces the activity of α -amylase or directly inhibits the activity of the enzymes (Ou *et al.*, 2001). Another study that investigated the β -glucans of oat meal also validated that muesli lowers the absorption of glucose and keep the postprandial blood glucose levels low. A longitudinal study also explained that long term consumption of cereal based breakfast and muesli showed positive effect on postprandial blood glucose levels and can be an effective therapy in people with type II diabetes (Xu *et al.*, 2019). A study also showed similar results in diabetics that consumed freshly prepared muesli and concluded that freshly prepared muesli effectively maintained the postprandial glucose levels low thus ensure gradual rise in intestinal glucose absorption and it could be an effective therapy against type II diabetes (Cheng *et al.*, 2023).

CONCLUSION

Muesli is a cereal-based breakfast that is consumed quite often. It contains a generous amount of fiber. Muesli meals due to their nutritional profile ensure supply of quality nutrition to the body. It provides calories along with proteins and carbohydrates. Muesli contains fiber and β -glucans that cause gradual rise in blood glucose level. It limits the absorption of glucose and carbohydrate digesting enzymes. These therapeutic properties make muesli a suitable dietary choice to manage post prandial blood glucose levels.

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