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# READYMADE FOXTAIL MILLET MIX FOR DIABETICS

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**ABSTRACT**
The diabetes population in India is increasing an alarming rate. At present India is recognized as 'capital of diabetes' due to high prevalence of diabetes in younger generation. Dietary management with high fibre and complex carbohydrate millets found beneficial in monitoring diabetes and to prevent further complications. The study was conducted to develop foxtail millet (Italian millet) based mix and test glyco-lipemic responses among diabetics. The diabetic mix was prepared with 80% foxtail along with 10% both wheat semolina and black gram *dal* and selected spices. The GI 54.39 was noted for initial foxtail millet mix and further reduced to 49.6 in modified mix. The feeding study of four weeks was conducted on nine type 2 diabetics and non diabetics as control group. The difference in the plasma glucose of experimental diabetic and non-diabetics with control group was significant ($P \leq 0.01$) and after intervention the fasting blood glucose reduced upto 16-19% in experimental subjects. The lipid profile of experimental subjects was improved after consumption of millet mix.

**KEYWORDS**: diabetes, millet, foxtail, wheat semolina, lipid profile etc.

## INTRODUCTION

Diabetes Mellitus is the most common metabolic disorder affecting humankind and creating health hazard. The prevalence of diabetes in India found to be 32 million in urban and rural areas during 2000 and predicted to reach 79.4million by 2030. Though diabetes is associated with aging the recent hike can be attributed to change in life styles, poor dietary habits and stressful events among the younger generations of 25-40 years and thus leading to premature deaths and disabling complications.

Dietary management is a good strategy in monitoring diabetes and avoiding further complications. At present, the recommended diabetic diet (ADA guidelines) consists of high complex carbohydrate, high fibre and low fat because it helps in minimizing the rise in post prandial hyperglycaemia and serum cholesterol. Several studies have shown that the carbohydrate along with high fibre (25g/1000 calories) has beneficial effect in improving glucose tolerance and insulin sensitivity. Studies have also demonstrated that the diet rich in complex carbohydrates delays gastric emptying and slows down glucose absorption which is advantageous for diabetics. Recent studies indicated that minor millets such as foxtail, little and barnyard are nutritionally superior to conventional food grains and exhibit hypoglycemic effect due to presence of higher proportion of complex carbohydrate, resistant starch and slow rising sugars (Krishnakumari and Thayumanavan, 1997). In addition, millets contain water-soluble gum β-glucans which improve glucose metabolism. Therefore, the millets are suitable in diabetic diet to improve metabolic control of glucose. Hence the present study was conducted with objective to develop foxtail millet based readymade mix and test the efficacy in terms of glyco-lipemic responses in long term feeding among diabetics.

## MATERIALS AND METHODS

Foxtail millet was procured from Agricultural Research Station of University of Agricultural Sciences, Dharwad. The diabetic mix was prepared using foxtail in major proportion along with wheat semolina and black gram *dal* and selected spices. Later the mix was modified by replacing semolina with black gram splits along with addition of cinnamon and turmeric powder in the spice mix. The proximate nutrients of the mix were analyzed using standard AOAC procedures. Carbohydrate and energy values were computed. The fiber profile of the mix was analyzed by rapid enzymatic method proposed by Asp *et al.* (1983). The glycemic index was estimated in ten non-diabetic subjects with 50 g carbohydrate load and calculated using the formula given by Wolever and Jenkins (1986). The glycemic load of the mix was calculated for 40g serving portion.

The long term feeding study of four weeks was conducted on nine type 2 diabetic and non diabetic volunteers. During intervention period the subjects were asked to replace part of the daily cereal intake by foxtail millet mix which was supplied in the polyethylene bags with clear instructions. Each subject consumed 87g of mix (80g mix + 7g spice mix) per day in breakfast/ lunch/ dinner according to their convinces and submitted the compliance report.

The fasting glucose, triglycerides, total cholesterol and HDL cholesterol values of venous blood was estimated in the beginning and end of feeding period of four weeks by using commercial enzymatic kits. The values of the variables obtained at the initial and end of feeding intervention period (4 weeks) were compared to assess efficacy in terms of biochemical evaluation.

## RESULT AND DISCUSSION

The foxtail millet was milled, cleaned by sedimentation technique, dried, dehydrated at 60°C for 4-5 hours and mixed at 80 % level in the mix. The mix was formulated by mixing roasted wheat semolina and black gram dhal at 10 % level along with at 8% spice mixture of fenugreek, coriander and cumin seeds, black pepper.

The diabetic mix was further modified by addition of split black gram dal to 20% along with reduction in fenugreek seeds to 40% in spice mixture. The mix was analyzed for their nutrient composition and dietary fibre profile and presented in table1.

**TABLE 1.** Nutrient composition of foxtail millet readymade mix (100gm)

| Nutrients | Initial mix | Modified mix |
|---|---|---|
| Protein (%) | 12.91 | 13.14 |
| Fat (%) | 3.47 | 3.66 |
| Carbohydrate (%) | 74.04 | 75.30 |
| Energy (kcal) | 379 | 386 |
| Total dietary fibre (%) | 21.40 | 22.29 g |
| Glycemic index | 54.39 | 49.60 |
| Glycemic load | 13.6 | 12.4 |

The protein, fat and carbohydrate content of foxtail millet mixes were 12.91and 13.14, 3.47 and 3.66 and 74.04 and 75.30 per cent in initial and modified mix respectively. The total dietary fibre content of initial and modified foxtail millet mix was 21.4and 22.29 per cent respectively. The energy values the mixes were ranged from 379 to 386 calories. The difference between the nutrients of both millets mixes was statistically not significant. The GI 54.39 was noted for initial foxtail millet mix reduced to 49.60 in modified millet mix. The glycemic load also reduced from 13.6 to 12.4 for same serving portion of the mix.

The experimental group for the feeding trial consisted of nine known diabetics with more than 4 years of the disease, on oral hypoglycaemic drugs and nine non diabetics along with six volunteers as control in each category. The profile of the subjects involved in clinical study is presented in table2. The mean age of diabetics ranged from 50.78 to 51 years while non diabetics 43.17-43.67 years. The mean weight of diabetics ranged from 69.40-74.83 kgs while non diabetics 64.33-66.00 kgs. The BMI of the diabetics ranged from 27.79-29.14 while non diabetics 24.07-26.10 with 0.89-0.94 waist hip ratio.

**TABLE 2.** Profile of the subjects selected for clinical intervention

| Parameters | Diabetics (N=15) | | Non Diabetics (N=15) | |
|---|---|---|---|---|
| | Experimental (n=9) | Control (n=6) | Experimental (n=9) | Control (n=6) |
| Male | 4 | 2 | 4 | 4 |
| Female | 5 | 4 | 5 | 2 |
| * Age (years) | 50.78 | 51.00 | 43.17 | 43.67 |
| * Weight (kg) | 69.4 | 74.83 | 64.33 | 66.00 |
| * BMI | 27.79 | 29.14 | 24.07 | 26.10 |
| *Duration of disease (years) | 4.11 | 4.50 | - | - |

*mean values

The millet based composite foods were given to nine type 2 diabetics and non-diabetics for the period of four weeks each. All the subjects were asked to consume the composite mix (80g) as regular food, either in breakfast, lunch and /or dinner convenient to their work schedule. Most of them consumed the millet mix in the form of rice, pancake, *upma* and *thalipattu* in every day meal. The blood analysis for glucose, total cholesterol, triglycerides and HDL- cholesterols of experimental and control subjects (N=30) were noted before and after feeding study. The fasting blood glucose before and after 4 weeks of feeding foxtail millet mix is tabulated in table 3. The triglycerides, total cholesterol and HDL- cholesterol before and after feeding study of foxtail millet composite food, were analyzed and tabulated in table 4.

It is evident from table 3 that 18.94 % and 15.55% reduction in plasma glucose of experimental diabetic and non diabetic group after consumption of foxtail millet mix. The plasma glucose increased upto 3.35% among control group. However, the plasma glucose was reduced two times more in non-diabetics after consumption of foxtail millet composite mix. The significant difference in plasma glucose was observed in the experimental and control groups ($r=0.006$) after the consumption of mix. The difference in the plasma glucose of experimental diabetic and non-diabetics was significant ($P \leq 0.01$).

It is evident from table 4 that the reduction in triglycerides from 2.99-3.62% and increase in HDL-cholesterol from 4.26-8.16% was observed in experimental diabetic and non-diabetics. While total cholesterol level reduced upto 5.89 per cent among diabetics compared to control diabetics (3% increase) after consumption of foxtail millet composite mix. It was interesting to know that HDL-cholesterol decreased by 2.75-3.23% among control groups. The difference in the plasma triglyceride, total cholesterol and HDL cholesterol was not significant statistically in experimental (diabetic and non diabetics) and control groups after feeding study of foxtail millet composite mix.

It is clearly noted from table 4 that reduction in plasma triglycerides by 4% and increase in HDL-cholesterol to 8% among non diabetic experimental group. There was no apparent change observed in triglyceride and total cholesterol level of diabetic experimental group after completion of feeding study.

The present investigation was focused on popularization of health benefits of foxtail millet mix among diabetics though it is traditionally accepted food. In present context reduced production of foxtail millet and its utilization other than food created nonavailability in local market at nominal cost. The glycemic index of the millet mixes was determined by the incremental glycemic response of the developed composite mix compared to reference meal (glucose) only in 10 non-diabetics. It is clearly established fact that GI for millets was found to be lower than other cereals *viz.,* rice , wheat, dicoccum wheat and sorghum. The glycemic load of the 40g of millet mix ranges in moderate category which highlighted its glycemic response and insulin demand in all meals of the diabetics.

**TABLE 3.** Effect of feeding millet mix on fasting blood glucose

| blood glucose mg/dl | Diabetics (N=15) | | Non Diabetics (N=15) | |
|---|---|---|---|---|
| | Experimental (n=9) | Control (n=6) | Experimental (n=9) | Control (n=6) |
| Initial | 117.33 ±17.54 | 119.83 ±17.22 | 94.17 ±7.88 | 92.00± 14.31 |
| Final | 95.11 ±15.78 | 123.00 ±11.13 | 78.67 ±7.68 | 92.50 ±16.16 |
| Difference (%) | 18.94 | 2.65 | 16.46 | 0.54 |

*mean values

**TABLE 4.** Effect of feeding millet mix on lipid profile

| Parameter | Diabetics (N=15) | | Non Diabetics (N=15) | |
|---|---|---|---|---|
| | Experimental (n=9) | Control (n=6) | Experimental(n=9) | Control (n=6) |
| Triglycerides(mg) | | | | |
| Initial | 137.56± 47.36 | 190.17± 36.90 | 133.33 ±39.26 | 157.22± 22.09 |
| Final | 133.44± 49.97 | 187.00± 49.69 | 128.50 ±52.73 | 155.83± 26.13 |
| Difference (%) | 2.99 | 1.67 | 3.62 | 0.88 |
| Cholesterol(mg) | | | | |
| Initial | 212.89± 46.97 | 221.33± 31.12 | 182.50± 43.83 | 197.00 ±26.34 |
| Final | 200.44 ±31.82 | 227.83± 41.58 | 182.33± 25.87 | 204.67± 32.98 |
| Difference (%) | 5.89 | 2.97 | 0.09 | 3.89 |
| HDL Cholesterol(mg) | | | | |
| Initial | 39.22 ±5.85 | 36.33± 3.78 | 45.00± 9.80 | 36.17± 8.70 |
| Final | 40.89 ±4.37 | 35.33 ±5.65 | 48.67± 9.20 | 35.00 ±6.45 |
| Difference (%) | 4.26 | 2.75 | 8.16 | 3.23 |

*mean values

The composite mix included 10 per cent pulse (black gram *dal*) and eight per cent spice mixture, which was beneficial to maintain normoglycemia in diabetics besides adding variety to the regular meal. Black gram *dal* and spices such as fenugreek seeds and coriander seeds exhibit hypoglycemic as well as hypocholesterolemic effect when included in diabetic diet as reported by Srinivasan (2005). The feeding of developed diabetic composite mix resulted in improving carbohydrate tolerance among experimental volunteers, as shown by reduction in fasting plasma glucose after four weeks. The cereal-pulse composite mix was found to be a beneficial combination ( Mani *et al.,* 1997 and Torangatti, G. and Naik, R., 1999) when utilized in the form of meal rather than individual food increased long term dietary adherence. About 65 per cent of experimental volunteers found within standard limits of glucose and lipids after feeding intervention of composite mix. In spite of short duration of the experimental period (4 weeks) considerable change was observed in positive direction with plasma glyco-lipemic parameters. Further the attempt was made to reduce glycemic index of the mix less than 50 in order to designate it as low glycemic food according to recent WHO classification. The long term clinical effect of the modified mix is in progress in Karnataka Medical Research Center Belgaum.

## CONCLUSION

The study focused on popularization of health benefits of known foxtail millet by developing ready to use mix. It is pointed out that glycemic index and load for millet mix was found to be lower than other staple cereals. On the whole inclusion of 80g mix in diabetic diet for four weeks improved their glyco-lipemic control.

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