The hypolipidemic effects of *Afzelia Africana* in type II diabetic patients in Nigeria

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Summary

Background: **The projected rise in the world prevalence of diabetes mellitus poses new challenges in poor countries. Soluble fibre incorporation into the diet of diabetic patients has been shown to reduce the glyceamia and lipaemia of diabetes mellitus.**

Design and method: **The hypolipidemic effect of soluble fibre supplementation using the seed of locally available legume tree plant – *Afzelia africana* was studied in 13 Nigerian patients with type 2 diabetes mellitus.**

The subjects were randomly selected from the out patient diabetes mellitus clinic of Nnamdi Azikiwe University Teaching Hospital, Nnewi.

They were fed with unsupplemented and supplemented standardized diet for the first 2 days and subsequent 4 days respectively.

The fibre supplementation was prepared and incorporated into the meal portions according to previously described technique and acceptability study.

Outcome measures: The fasting serum levels of TC, TG, HDL-C, LDL-C and HDL/TC ratio were estimated before and after the unsupplemented and fibre supplemented meals. The data obtained were analyzed using paired t-test.

The correlation between the total energy requirement and the reduction in TC, pre and post fibre supplemented meals were determined using the linear coefficients.

Result: **The results showed a significant reduction (P<0.05) in mean fasting TG, LDL-C and improvement in HDL/TC ratio following a 4 day supplemented meal.**

The relation between the difference in TC before and after the supplemented meal and total energy requirement was not significant (P> 0.05).

Conclusion: **The exploitation and incorporation of this source of soluble fibre in diabetic diets reduced the lipaemia of diabetes mellitus.**

Key-words: *Diabetes mellitus, Dietary fibre, Afzelia africana (Akparata), Dietary management, Hypolipidemic.*

Résumé

Introduction: La hausse prévue dans la fréquence de la diabète pancréatique partout dans le monde des nouveaux défis dans les pays pauvres. L'incorporation de la fibre soluble dans l'alimentation des diabètiques est déjà demontré attribuable à la diminution de la glycérmie et la lapaemie de la diabète pancréatique.

Plan et Méthode: L'effet hypolipidémique de la supplémentation de la fibre solution à travers l'utilisation de la graine de la légumineuse localement disponible - Afzelia Africana était étudiée chez 13 patients nigérians atteints de la diabète pancréatique. Les sujets ont été choisis au hasard parmi les patients de la diabète pancréatique du service des consultation externes du centre hospitalier univertaire d'Nnamdi Azikiwe, Nnewi. Ils ont été nourris d'un régime alimentaire équilibre supplémente et non supplémenté pendant les deux premier jours et les 4 jours suivant respectivement. La supplémentation de la fibre a été préparée et incorporée dans le repas d'après la technique et l'étude acceptée et décrite auparavant.

Résultats des mesures: Les niveaux du sérum de la diète du rapport TC, TG, HDL-C, LDL-C et HDL/TC ont été évalués avant et après des repas non supplémentés et fibre supplémentée. Les données obtenues on été analysées à travers la méthode t-test formé des couplets. La corrélation entre l'énergie totale requisse et la baisse dans le TC, pré et post repas fibre supplémentée ont été décidées à travers l'utilisation du coéfficient linéaire.

Résultats: Les résultats ont indiqué une baisse importante (P<0,05) en ce qui est de moyen de la diète TG, LDL-C et amélioration dans la proportion HDL/TC à la suite d'un 4 jours repas supplémentés. Le rapport entre la différence de TC avant et après le repas supplémenté et l'énergie totale requise n'était pas importante (P<0.05).

Conclusion: L'exploitation et l'incorporation de cette fibre soluble dans l'alimentation du diabetique diminue la lipaemie des diabetes pancréatiques.

Introduction

The WHO estimated that the worldwide prevalence of diabetes mellitus in individuals aged 20yrs and above would rise to 5.4% with a total diabetic population of 300million by the year 2025[1].Developing countries will have 170% increase and will be contributing significantly to the overall burden[1].

Comprehensive reviews of the African diabetes situation suggested an overall increase in prevalence of Type 2 diabetic population[2,3]. A recent survey in Nigeria showed that diabetes mellitus affects about 1% to 7% of the population with non-insulin dependent forms contributing over 90%[4,5].

The profile of the African diabetic patient indicated that type 2 patients with low BMI, reduced β cell function and infrequent association with ketonurea were most commonly encountered in South Africa[6,7]. Data on the diet of African diabetic patients are scanty, yet in many African cultures, female obesity, projecting qualities of good health, affluence, fecundity and sexual attractiveness continue to be glorified[7].

Their negative influences on the diabetic situation have not been helped by increasing urbanization and its attendant dependency on processed food that are calorie dense but deficient in fibre.

Elsewhere, studies have shown the importance of dietary fibre in the overall glycaemia and lipaemia control and improvement in the morbidity and mortality characteristics of diabetic patients[8,9,10].

Otabe et al[8] showed that unrefined food with significantly higher fibre content resulted in significantly better glycaemic control than refined processed food when fed to 15 diabetic patients. Similarly Baker[9] showed that the addition of wheat bran to bakery products led to reduced blood glucose and improved peripheral insulin activity in their subjects. Jenkins[10] suggested that the low glycaemic index or lente carbohydrate slowed the rate of carbohydrate absorption and resulted in the reduction of post prandial glycaemia or insulinaemia and of LDL-cholesterol as well as apolipoprotein B concentrations.

The counter wood tree *Afzelia africana* – (a leguminous plant whose leaves serve as common vegetable source in Eastern parts of Nigeria) – produces seeds whose cotyledons have been in use traditionally (Akparata) as soup thickeners in Eastern parts of Nigeria. Ene-Obong and Carnovale[11] found a dietary fibre content of 37.4% (with approximately 2/3 soluble fibre) in these seeds.

The present study assesses the impact of dietary fibre (supplementation) from *Afzelia africana* seed (Akparata) on the lipaemic responses in Nigerians with type 2 Diabetes mellitus.

Subjects and methods

The subjects were selected from the outpatient NIDDM population [of the Nnamdi Azikiwe University Teaching Hospital, Nnewi (NAUTH)], who were without renal disease, hypertension, liver disease, heart failure and concommitant endocrine disorder (thyroid, pituitary, adrenal, gonads). Patients with malabsorption disorder or inflammatory diseases were also excluded from the study.

Informed and written consent was obtained from each of the subjects and they were at liberty to withdraw from the study at any stage. All the subjects had attended the weekly diabetic education programmes at the outpatient clinic of the NAUTH, and also attended the Day - 0 seminar discussions on the study. The subjects were encouraged to continue with their daily routine during the study period. Transportation was provided to encourage compliance with the study time schedules.

The dietary fibre supplement was obtained from *Afzelia africana* as previously described[11,12]. The *Afzelia africana* nuts were roasted with sand for 10 – 15 minutes, cracked and milled into fine powder. The powder was then sundried for storage.

The study lasted for 6 days. The days 1 and 2 were used for control and stabilization and the subjects were fed with unsupplemented diet portions. In days 3 to 6 supplemented diet portions were used. The menu were drawn from the local meals and were prepared by the nutrition and dietetics kitchen of the NAUTH according to previously standardized calorie

and recipee[12]. Two types of breakfast/dinner pairs were served on alternate days while lunch was the same throughout the study period. The time schedules for the meals were the same for the period. Except for water, which was allowed freely no additional snack/meal was allowed during the study.

The total daily calorie requirement for each subject was estimated based on the calorie required to maintain the basal metabolic rate (BMR) for the body mass index (BMI) plus the calorie required for the estimated daily activity level[13]. The BMR calories were divided evenly through the day, while the activity level dependent calories were divided arbitrarily in a ratio of 1: 2: 1 for breakfast, lunch and dinner for each subject.

The meals were served in portions. A portion was defined as the quantity of food that contained the calorie equivalent to maintain the BMR for BMI of 25kg/m^2.

Five grams of dried fibre powder was added as fibre supplement per meal portion.This fibre supplement ratio was based on a previous fibre supplement acceptability studies in our locality[12].

The personal data and details of medical and diet (regularity, components, snack, habits) history of the subjects were entered into a proforma. The findings on physical examination (including weight, height and inter shoulder width) were similarly recorded.

Venous blood sample were drawn from the subjects into vacutainers following overnight fast on days 1, 3 and 7 of the study. The samples were allowed to clot, centrifuged and the serum samples stored at –20 ^{0}C for the subsequent determination of total cholesterol (TC), HDL- cholesterol (HDL-C) and triglyceride (TG).

The analyses were done in batches of 10. For each batch a blank and standard controls were included. The TC and TG were determined by enzymatic (reagents and standards supplied by Teco diagnostics 911 VIA RODED Placentia CA 92670 and Teco diagnostics 4925 E Hunter and Anaheim CA 92807 respectively), spectrophotometric (Spectronic 20 Milton Roy Co.) methods. The HDL-C was determined using commercially available kit (B283 Linear Chemicals). The low density lipoprotein (LDL – C) was calculated using the method of Friedwald et al [14].

The mean (±SD) values of the lipid levels before and after the test meals were compared parametrically for statistical differences using the Student's t-test.

The subjects were subdivided into 2 groups according to their total energy requirement. The relationship between the groups and their TC differences (the difference of TC values before and after consumption of the test meals) were examined using linear regression and correlation coefficients. Data obtained were tabulated and statistical significance was set at P< 0.05.

Results

The total number of registered diabetic patients was 772 at the inception of the study. Only 263 of them satisfied the inclusion criteria and of these 13 were selected for the study. These consisted of 9 males and 4 females. Three males were unable to complete the study because of difficulties in com-

Table 1 Characteristics of the diabetic subjects

Subjects	Age (yrs)	Sex	Weight (kg)	Height (m)	BMI (kg/m2)	Daily energy (kj)	Duration of DM (yrs)
1	70	M	82	1.80	25.31	5500	1
2	37	F	68	1.60	26.56	6450	1
3	52	F	44	1.62	16.77	5650	1
4	46	M	86	1.73	28.73	7000	10
5	45	M	74	1.64	27.51	7500	4
6.	55	F	67	1.68	23.74	7000	1
7.	49	F	57	1.55	23.73	6650	1
8.	46	M	61	1.68	21.61	6850	9
9.	48	M	61	1.61	23.53	7200	8
10.	52	M	72	1.65	26.45	5650	6
Mean	50	M=6	67.2	1.66	24.39	6545	4.2
± SD	±8.59	F = 4	±11.67	±0.07	±8.20	±657.44	±3.54

Table 2 Fasting serum lipid level of the diabetic subjects on day 1, 3, and 7

Subjects	Day 1				Day 3				Day 7			
	TC	TG	HDL-C	LDL	TC	TG	HDL-C	LDL	TC	TG	HDL-C	LDL
1.	4.3	1.3	1.4	2.04	3.9	2.2	1.4	2.06	3.2	2.0	1.8	1.0
2.	4.4	2.6	1.6	2.28	4.1	2.2	1.5	2.16	3.5	1.9	1.7	1.42
3.	3.8	1.2	1.3	2.26	3.6	1.5	1.3	2.0	3.3	1.2	1.5	1.56
4.	4.7	1.1	1.5	2.98	4.5	1.2	1.4	2.86	5.3	1.1	1.7	3.3
5.	3.7	1.5	1.3	2.1	3.9	1.8	1.1	2.46	4.2	1.3	2.1	2.28
6.	4.6	1.3	1.8	2.4	4.2	1.4	1.2	2.14	3.7	1.4	1.7	1.74
7.	4.4	2.0	1.4	2.74	4.3	2.0	1.7	2.42	4.4	1.3	1.7	2.72
8.	4.1	1.7	1.5	2.38	4.3	1.9	1.6	2.48	4.0	1.0	1.4	2.3
9.	3.6	1.5	1.6	1.7	3.6	1.1	1.6	1.9	3.0	1.0	1.3	1.14
10.	5.2	1.8	1.7	3.14	5.0	1.2	1.3	3.12	4.3	1.5	1.6	2.7
Mean	4.28	1.6	1.51	2.40	4.14	1.65	1.41	2.36	3.89	1.37	1.65	2.02
± SD	±0.50	±0.46	±0.17	±0.44	±0.42	±0.42	±0.19	±0.39	±0.69	±0.35	±0.22	±0.76

TC - Total cholesterol
TG - Triglyceride
HDL-C - High density lipoprotein cholesterol
LDL-C -Low density lipoprotein cholesterol

plying with the time schedules. Thus, 10 subjects, 6 males and 4 females completed the study and were the subjects of further analysis.

Their mean age was 50.0 ±8.59yrs (range 70 – 37 yrs). The mean duration of diabetes mellitus since diagnosis was 4.2 ± 3.54 yrs (range 10yrs – 1 Yr). Seven of the subjects were on sulfonylurea while 3 were on long acting monocomponent porcine insulin. The latter patients (2 males, 1 female) had healed foot ulcers that involved the toes and/or fore foot.

The mean BMI of the subjects was 24.39 ±8.20 kg/m^2 (range 28.73 – 16.77kg/m^2), Table 1. Nine of the subjects engaged themselves in moderate physical activities daily [Activity of daily living, household chores and in addition selling and buying endeavours (7), restaurant services (1), town service driving (1)]. While one was engaged in severe physical activity daily [an unskilled labourer working at a construction site]. The estimated total daily calorie requirement of the subjects ranged from 5,500KJ to 7,500KJ. Four of the subjects required between 5,500KJ and 6,500KJ per day (Group A) while six required between 6,500Kj – 7,500KJ per day (Group B).

Eight of the subjects had regular meal pattern. Seven subjects more often than not ate varying quantities of fruits and leafy vegetables in between meals. The other three consumed vegetables and fruits infrequently.

Table II shows the serum lipid levels of the fasting blood samples taken on the various observation intervals. The mean fasting TC, TG, HDL-C and LDL-C of days 1 and 3 did not differ significantly.

Seven of the subjects showed an increase, two showed a decrease, while one showed no change in serum HDL – C between day 3 and day 7. Although the mean HDL – C of day 7 was higher than that of day 3, the difference falls short of the significant level (P>0.05).

The mean LDL-C of day 7 was significantly lower than that of day 3 (t = 2.57 on 9df, P< 0.05). Also the mean TG level of day 7 was significantly lower than that of day 3 (t = 3.1, on 9 df, P<0.02). Although the mean TC level of day 7 was lower than that of day 3, the difference was not statistically significant. The difference in serum TC of days 3 and 7 correlated poorly with the total daily energy requirement of the subjects (r = 0.11, a = 1.55; b = 0.03). The mean value of HDL-C/TC ratio of day 7 was significantly higher than that of day 3 (t = 2.73 on 9df P<0.05).

Discussion

The characteristics of the subjects in the study generally reflected the attendance at the outpatient diabetic clinic of the NAUTH. Osuafor reviewed the first 100 consecutive patients with diabetes mellitus seen at the NAUTH and found a male to female ratio of 1.6:1[15]. The National Non communicable diseases Survey found a slight female excess in the prevalence of dibetes mellitus in Nigeria[5]. Elsewhere in the world diabetes appear to be more common in women[1]. In Japan however, Islam et al [16] reported an increasingly upward trend in prevalence of diabetes mellitus among males. The WHO estimated a preponderance of males with diabetes mellitus in sub-Saharan Africa by the year 2025[1]. The mean age of the subjects in this study compared favourably with that reported in other studies on Type 2 diabetes mellitus[1,4,5,15].

About 50% of the subjects in this study had BMI above 25 kg/m². The importance of obesity factor in Type 2 diabetes among Africans remained unemphasised. Nevertheless, emerging data indicate that in consonance with Type 2 diabetes elsewhere, adult diabetes in Nigeria is associated with overweight[5,17].

A larger proportion of the subjects had regular meal pattern and consumed vegetables and fruits with their meals. A similar proportion also ate fruits in between meals. These findings contrast with the observation of Zohra et al [18]. The systematic and goal directed diabetic education program at the NAUTH diabetic clinic probably contributed to the observations in this study. John et al[19] found that structured systematic teaching were more effective than casual teaching in imparting knowledge and skill in self care among diabetic patients in Calabar.

A significant fall in the mean fasting serum triglyceride and LDL-Cholesterol levels following 4 days feeding on the test diet were observed in this study. Incorporation of soluble fibre in the meal, resulted in a feeling of fullness after the meal, a reduced tendency to eat more (and thus, an overall reduction in fat intake), slowed nutrient digestion and absorption and favourable alteration in serum lipid metabolism[10,20].

Although both mean values of serum triglyceride (pre and post test meal consumption) were within the normal range, 50% of the subjects had pre test meal serum triglyceride values greater than 1.7mmol/l. This proportion dropped to 30% after the 4 days supplemented test meal consumption. In the diabetic state,events of the postprandial state often continue beyond the physiologic postprandial period to occupy most of the nyctohemeral interval. Consequently, the magnitude of the abnormalities in the metabolic and hormonal profiles after an overnight fast often reflects these continued postprandial events[21].

The atherogenic potentials of small dense LDL subclass consequent upon elevated serum triglycerides have been established[21,22]. Also recently, postprandial hypertriglyceridaemia and in particular postprandial triglyceride rich remnants have been associated with increased cardiovascular disease[21,22,23].

The lack of correlation between total calorie requirement and change in TC following consumption of the supplemented test meal remained unclear. Introduction of hypolipidaemic agents has been observed to lead to greater decreases in TC in individuals with larger initial BMI[24,25] and improved protective potentials for cardiovascular health. The observations in the present study might be related to differences in the mechanisms of reduction of TC and/or the contribution of the calorie required for the individual subject's physical activity to the total estimated calorie.

There were significant improvements in the cardiovascular risk predictor ratio observed in this study. In conclusion, soluble dietary fibre, sourced from *Afzelia africana* – a locally available leguminous tree plant – when incorporated into the diet of Nigerians with type II diabetes mellitus resulted in significant reduction in fasting serum triglyceride and LDL – cholesterol levels.

There was overall significant improvement in the value of the HDL-C/TC ratio.

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