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Protective Role of Raw-Turmeric Rhizomes Against Nicotine-Induced Complications of Beedi (Indian Cigarette) Workers

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Abstract

Introduction: The unscientific process of beedi (Indian smoking element) production under constant exposure of nicotine dust in India induces serious health disorders to the workers. Beedi produces more tar in smoke than cigarette due to lack of any filtering process. Sometimes active consumption of beedi and other tobacco products makes the users more vulnerable to cancer, respiratory diseases and cardiovascular disorders etc.

Objective: The present study was designed to observe the protective effects of raw turmeric rhizomes on health conditions of the beedi workers who were exposed to nicotine dust for 8-10 hours daily for a long duration.

Methods: General health checkup, blood glucose levels, lipid profiles and the hemogram profiles etc. of the workers from two beedi factories (Canning of South 24 Parganas District and Bankura of Bankura District, both in West Bengal, India) were conducted before and after the consumption of laboratory processed raw turmeric rhizomes (80 mg/kg body weight/day by chewing) for 8 weeks. Blood samples (5 ml) were collected from all the workers before and after the completion of the study and analyzed for estimation of different parameters.

Results: The results showed significant improvement in the general health conditions of the factory workers who consumed raw-turmeric rhizomes. Significant improvement of blood pressure, blood glucose levels and lipid profiles and also improvement of creatinine, serum protein and SGOT/SGPT levels of the treated volunteers were noted. The results also showed improvement in the enzymes levels of SOD, GSH and GP_x in the serum of rhizomes consumed workers.

Conclusion: It is concluded that turmeric rhizomes are effective in the amelioration of nicotine-induced complications. It would be a better therapeutic supplement for the improvement of health for the workers who are compelled to work under nicotinic dust environment for a long time.

Keywords: Blood pressure, Lipid profile; Nicotine toxicity; Oxidative stress; Turmeric rhizomes

Introduction

Tobacco epidemic is one of the worst public health threats to the world [1]. Approximately one person dies every six seconds due to smoking or consumption of various tobacco products which accounts for one in 10 adult deaths. Nicotine, behind the main culprit of tobacco, is poorly absorbed from the stomach because of its protonated (ionized) form in the acidic environment of gastric fluid whereas; it is well absorbed in the small intestine due to more alkaline pH and large surface area [2]. Nicotine base is also well absorbed through the skin that causes the occupational risk of nicotine poisoning (green tobacco sickness) in tobacco harvesters exposed to wet tobacco leaves [3]. Nicotine also has an affinity for melanin-containing tissues due to its precursor function in melanin synthesis. It irreversibly binds with melanin and increases nicotine dependence that lowers smoking cessation rates in darker pigmented individuals [4]. Smoking habit is associated with the free radical scavenger system in serum and neutrophil and also lowered body weight [5]. Tobacco smoke increases the formation of reactive oxygen species (ROS) and toxic chemical loads consequently increases cardiovascular as well as other circulatory diseases [6]. Nicotine also aggravates DNA single strand break resulting in the higher percentage of DNA damage under protein-restricted condition [7,8]. It is a risk factor for oral cancer [9], periodontal disease [10] and osteoporosis [11].

Beedi (poor man's cigarette) is the Indian version of cigarette in which tobacco flake is wrapped in Tendu leaf and tied with string. Beedi

accounts for 48% of tobacco consumption in India [12]. Although the number is decreasing, still beedi remains as one of the major smoking elements in India. There were 4.2 million beedi workers in India as estimated in 2002 [13]. The process of making beedi is unscientific and labor intensive for which the workers are compelled to stay in the factory for 8-10 hours a day under constant exposure to the nicotine dust and fumes. Under such conditions for several years, the workers suffer from respiratory disorder and numerous health issues. Apart from this, several workers are also active consumers of beedi and different forms of tobacco products. Beedi also produces more tar than cigarette in the smoke, as it does not have any filter. This increases the chances of cancer, respiratory diseases and cardio vascular disorder.

Turmeric rhizomes are widely used by the Indian people from ancient ages for various purposes like wound healing, cosmetics, cooking as well as in Ayurveda as medicines [14]. Rural people from India are habituated to consume raw turmeric rhizomes as Ayurveda

agent in their daily lives. Curcumin, the yellow-pigmented fraction of turmeric, is the key component that exhibits a wide range of beneficiary effects including anti-inflammatory [15,16], hypo-cholesterolemic [17], anti-infection [18] and anti-carcinogenic effects [19] etc. It has been already established that curcumin possesses a significant ameliorative property against nicotine-induced toxicity, especially in restricted protein condition in albino rats [7,20]. Curcumin is a costly compound, whereas turmeric rhizome (main source of curcumin) is cheap and easily available due to abundance in the market.

The effect of curcumin against nicotine-induced toxicity has been already established. We wanted to observe the efficacy of the raw turmeric rhizomes; the cheap source of curcumin which is easily available in the market against nicotine-induced complications of the workers who worked under nicotine environment. This study describes the beneficial effects of the consumption of raw-turmeric rhizomes on health conditions, particularly to beedi factories workers who belong to the lower socio-economic section of the society as well as under malnourished conditions.

Materials and Methods

Collection of raw-turmeric rhizomes

Raw-turmeric rhizomes were collected from the authenticated farmers of South 24-Paraganas, West Bengal, who are engaged to cultivate turmeric rhizomes in the field. The rhizomes were brought to the laboratory and cleaned with distilled water for several times for processing. The laboratory processed rhizomes were then cut into small pieces (2–3 g in weight) and packed in batches of 100 g in sealed Teflon bags for future uses.

Experimental subjects and category

The study was conducted on 90 volunteers (30–60 year ages) out of which 30 volunteers were chosen from normal healthy individuals i.e., not addicted with nicotine of any kind. Rest of the 60 volunteers was selected from the workers of two beedi factories of West Bengal (Canning, District South 24 Paraganas and Bankura, District Bankura). The study was performed on those volunteers who had verbal consent to consume the rhizomes. The volunteers were divided into 6 groups having 15 people in each group as follows:

Group A – This group was taken as control in which the participants had no nicotine exposure of any kind and comprised of healthy individuals.

Group B – The volunteers in this group also had no nicotine exposure. They were supplemented with laboratory processed raw-turmeric rhizomes (80 mg/kg body weight/day) to consume for 8 weeks.

Group C – The volunteers in this group were exposed to nicotine dust for more than 10 years but not addicted to smoking and treated as passive nicotine consumed group.

Group D – This group also consisted of passive nicotine consumed volunteers who were advised to consume laboratory processed raw-turmeric rhizomes (80 mg/kg body weight/day) by chewing for 8 weeks.

Group E – The volunteers in this group were under nicotine exposure for more than 10 years as well as they were addicted to tobacco smoking or chewing tobacco products. This group was treated as active nicotine consumed group.

Group F – This group also consisted of similar type of volunteers as active nicotine consumed group and were given laboratory processed raw-turmeric rhizomes (80 mg/kg body weight/day) to consume by chewing for 8 weeks.

Study design inquiry

One the first day of the study, the general health of the participants were monitored. Body weight, pulse rate and blood pressure were measured. Inquiries were made regarding their general health conditions, nicotine consumption behavior and dietary habits. Blood sample (5 ml) was drawn from each participant with the help of a registered medical doctor and stored both in heparinized (2 ml) and non-heparinized (3 ml) sealed containers for further analysis. The fasting blood glucose level was measured using Breeze2 glucometer supplied by Bayer Healthcare LLC, USA. Laboratory processed raw-turmeric rhizomes were given to 50% participants for consumption for a period of 8 weeks at a dose of 80 mg/kg body weight/ day. The general health checkup, blood collection and fasting blood glucose level test were repeated for all the participants after 8 weeks.

Biochemical analysis

The blood samples collected from all the volunteers in each group (both before and after consumption of raw-turmeric rhizomes) were taken to the Department of Physics, Jadavpur University for analysis. Blood haemoglobin was determined from heparinized blood sample by using Sahli Haemometer, manufactured by Superior, W. Germany. Serum was isolated from non- heparinized blood sample and the total protein content of serum was estimated using the method of Lowry et al. [21].

Total cholesterol was measured using the kit provided by Accurex Biomedical Pvt. Ltd., Mumbai, India [22]. Urea [23], alkaline phosphatase (ALP) [24,25], SGOT and SGPT [24,26] were measured using individual kits provided by Piramal Healthcare Limited, Mumbai, India. Triglyceride was measured using kit provided by Merckotest®, Merck, Goa, India [27]. Creatinine was determined by kit using the modified Jaffi's method provided by Merckotest®, Merck, Goa, India [28]. Lipid peroxidation was determined by Thiobarbuturic Acid test (TBA test) with modification by Kumar and Das [29]. SOD activity was assayed by the method of Beauchamp and Fridovich [30] based on the reduction of nitroblue tetrazolium (NBT) to blue pharmazone by superoxides, produced phytochemically in the reaction system. Reduced glutathione (GSH) was obtained using method of Davila et al. [31] and glutathione peroxidase (GPx) was obtained using the method of Levander et al. [32].

Statistical analysis

Each experiment was repeated twice and the data of each individual was averaged. Each group contained 15 individuals, thus the percentage of change of each individual was calculated from the results obtained before and after the consumption of raw-turmeric rhizomes and finally averaged for each group. The results were presented in bar diagram. The statistical significance was determined using the One way analysis of variance (ANOVA). Significance levels were considered at $P < 0.05$ (denoted as *) for significant and $P < 0.01$ (denoted as **) for more significant.

Results

Almost all the volunteers as advised completed the rhizomes course according to the study guide lines. It was noted that more than 50% of the factory workers were under weight. The body weight as observed was slightly decreased for the volunteers of control group (Group A)

and nicotine exposed groups (Group C and E). Slight increment of body weight was noted to the raw turmeric supplemented groups (Groups B, D and F) as shown in (Figure 1). The body weight of all the volunteers in the passive nicotine exposure group (Group C) were seen to decrease whereas the body weight of the volunteers in Groups D and F, were observed to increase about 17% and 52% population wise respectively when consumed raw turmeric rhizomes (Figure 1).

The postprandial blood glucose levels of the volunteers in control group (Group A) were seen to remain within normal range (< 140 mg/dl). The postprandial blood glucose levels of the volunteers who consumed raw turmeric rhizomes (Groups B, D and F) were significantly decreased compared to their respective control (Figure 2). In case of nicotine exposure group (Group C), about 30% of the participants as surveyed were diabetic or pre-diabetic. There was an overall trend of increase in postprandial blood glucose level to the volunteers in Group
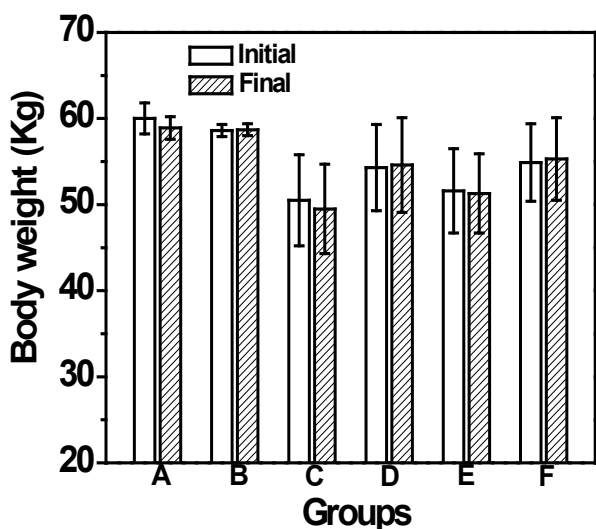

Figure 1: Comparison of initial and final body weights of different groups of volunteers.
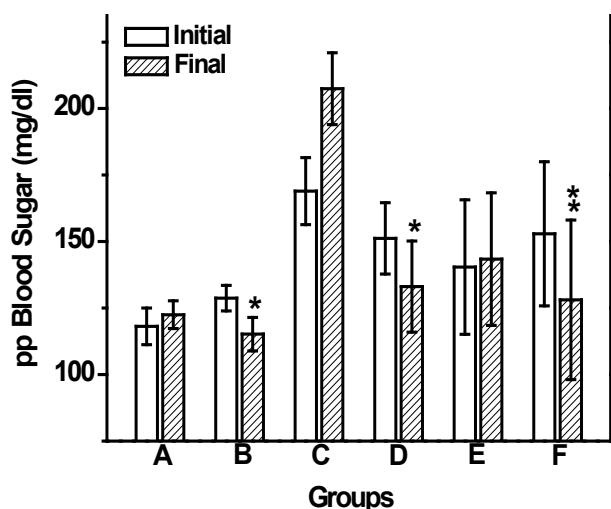

Figure 2: Comparison of initial and final pp blood glucose levels of different groups of volunteers.
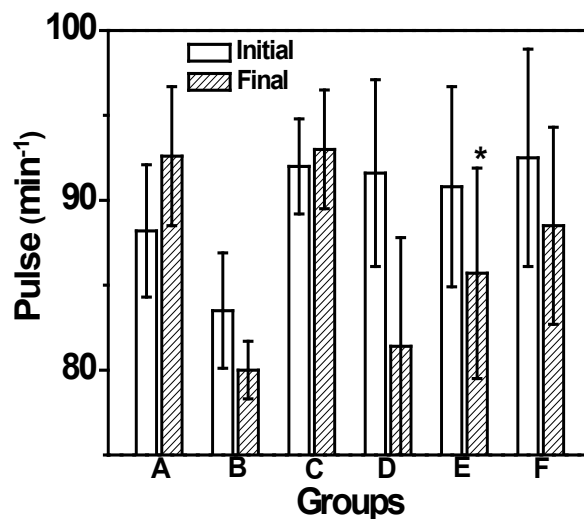

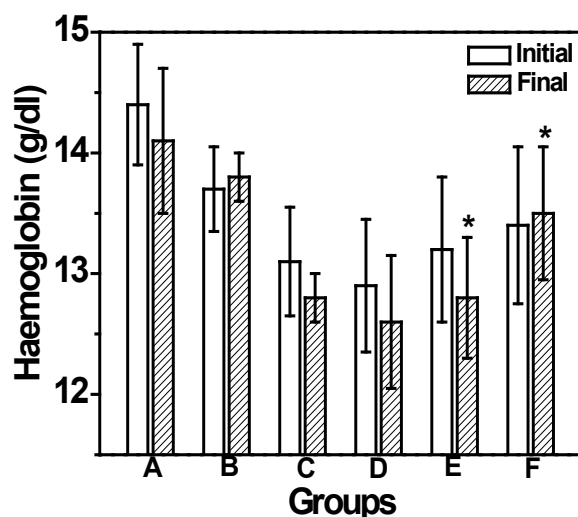Figure 3: Comparison of initial and final pulses of different groups of volunteers.

Figure 4: Comparison of initial and final haemoglobin concentrations of different groups of volunteers.

C who did not receive raw turmeric rhizomes. Significant reduction of the postprandial blood glucose levels were seen for the turmeric rhizomes consuming volunteers in Group D and F both in population and value wise (Figure 2).

The average pulse of all the volunteers who were exposed to nicotine in any way was found to be higher than that of the unexposed volunteers. There was a reduction of pulses noted for the volunteers in all groups who were supplemented by raw turmeric rhizomes compare to their pair fed control (Figure 3). It was also noted that the blood pressure (both systolic and diastolic) of the volunteers in the respective control groups (Groups A, C and E) who did not consume turmeric, remained almost unaltered (Table 1). On the other hand the blood pressure of the volunteers in the turmeric consumed groups (Groups B, D & F) was significantly reduced both in population and value wises. (Figure 4) summarizes the haemoglobin concentrations for all the volunteers. It was observed that the haemoglobin concentrations

Group		Average (mm Hg)	%Decrease	%Increase	%No change
A	Initial	124.4±23.6 85.2±16.6	0	66.7	33.3
	Final	126.3±25.2 86.1±13.2	0	3.2 ± 0.5	0
	Population Change in Value	-	-	-	-
B	Initial	128.4±27.7 83.8±15.5	100	0	0
	Final	120.5±23.3* 78.2±16.8	100	0	0
	Population Change in Value	-	-	-	-
C	Initial	138.5±26.7 86.2±18.9	57.4	42.6	0
	Final	139.4±27.7 88.0±14.9	12.2 ± 3.0	15.2 ± 0.2	0
	Population Change in Value	-	-	-	-
D	Initial	139.2±29.3 84.1±12.6	82.4	5.9	11.8
	Final	129.5±23.4** 78.4±8.6	11.0 ± 5.9	4.7 ± 1.0	-
	Population Change in Value	-	-	-	-
E	Initial	138.7±14.9 83.7 ±7.2	70.5	17.7	11.8
	Final	136.41±9.4* 80.3 ±7.6	13.7 ± 3.5	14.7 ± 2.1	-
	Population Change in Value	-	-	-	-
F	Initial	143.5±24.3 82.9 ±10.4	76.2	4.8	19.0
	Final	129.2±18.2** 78.9 ± 9.4	14.3 ± 2.1	6.5 ± 3.1	-
	Population Change in Value	-	-	-	-

Table 1: Blood Pressure
Values are given mean ± SD. N= 15; Using the paired student's t-test, significance levels were considered at $P < 0.05$ (denoted by *) for significant and $P < 0.01$ (denoted by **) for more significant. Normal range: 130/80 and 90/60 mm of Hg

decreased for those volunteers who were not supplemented with raw turmeric rhizomes. Whereas raw turmeric rhizomes helped to maintain haemoglobin contents of some volunteers to some extent as observed in Groups B and F. It was seen that the total serum protein was less for the nicotine exposed volunteers when compared to unexposed volunteers (Figure 5). The total serum protein was slightly increased for the volunteers who consumed raw turmeric rhizomes (Figure 5). The result of cholesterol levels as determined in this experiment was quite significant. The levels of cholesterol were higher for all those volunteers who were under constant nicotine exposure (Figure 6). It was seen that the cholesterol levels were reduced (30 - 65%) in population wise for the nicotine exposed volunteers who were supplemented with raw turmeric rhizomes (Groups D and F). Similar decrease in triglyceride levels were observed for all the participants who consumed raw turmeric rhizomes (Groups B, D and F) with respect to their pair fed control (Figure 7). It was noted that more than 35% decrease in triglyceride value of 64.7% population to the volunteers of Group D who consumed raw turmeric
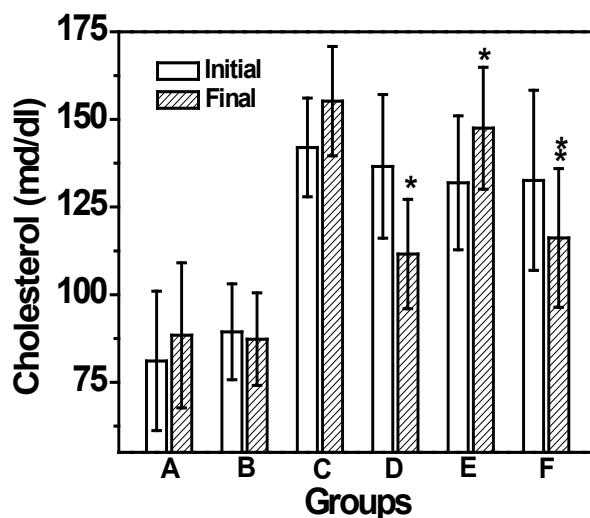
Figure 6: Comparison of initial and final total cholesterol of different groups of volunteers.
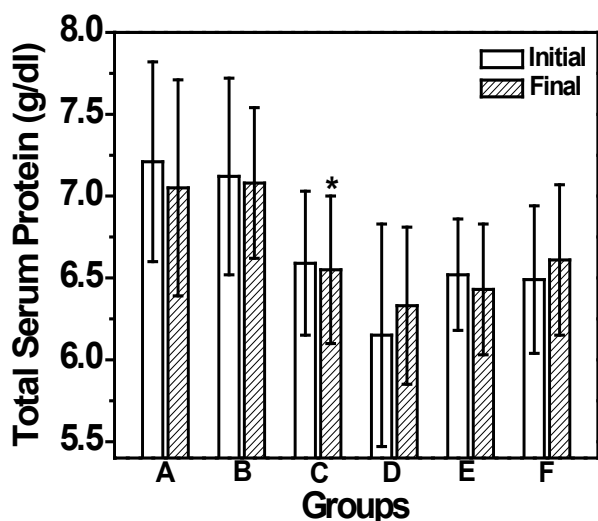
Figure 5: Comparison of initial and final total serum proteins of different groups of volunteers.
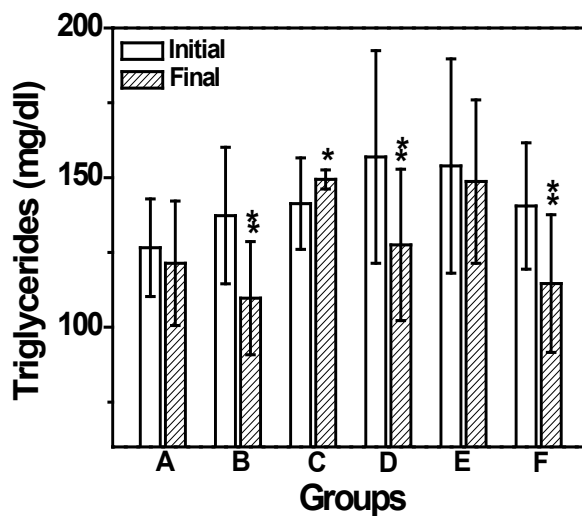
Figure 7: Comparison of initial and final triglycerides of different groups of volunteers.

rhizomes which was very much significant. Similar trends were also observed for Group E and Group F respectively. (Figure 8) summarizes the VLDL-C levels of all the volunteers which are again very much similar to that of the triglyceride result (Figure 7). Raw turmeric rhizomes perhaps had no effect on lipid peroxidation as revealed from the results shown in (Figure 9).

Raw turmeric showed no adverse effect on urea (Figure 10), creatinine (Figure 11) and SGOT (Figure 12) levels when used by the volunteers. Rather it decreased those levels when consumed by the volunteers. There was no significant effect of raw turmeric as noted in SGPT levels of all the volunteers (Figure 13). An increase of GSH and GPx levels was observed for all the volunteers who consumed raw turmeric rhizomes which were very significant (Figure 14 and Figure 15). The turmeric rhizome also showed its antioxidant activity by increasing the SOD activity as noted for the volunteers who consumed it (Figure 16)
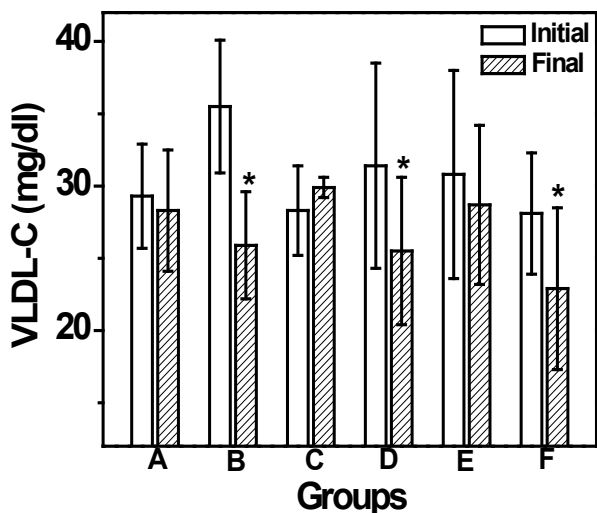

Figure 8: Comparison of initial and final VLDL-C of different groups of volunteers.
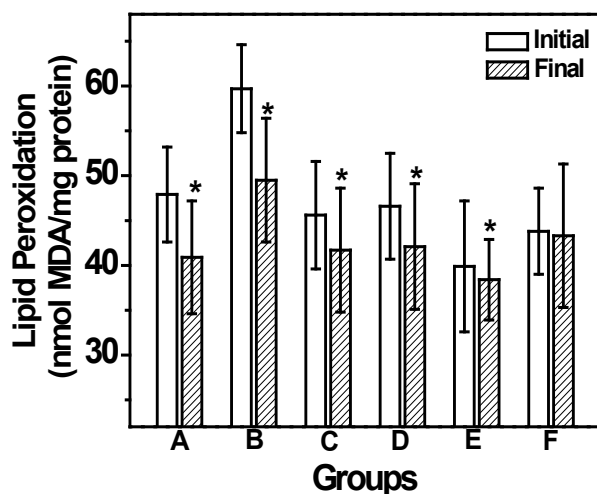

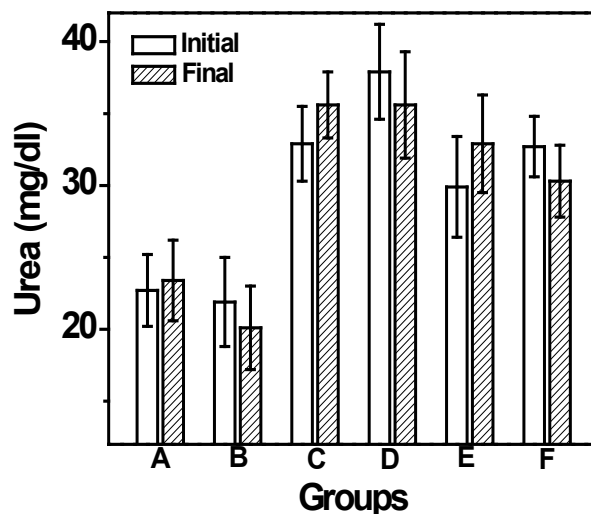**Figure 9:** Comparison of initial and final lipid peroxidation of different groups of volunteers.

Figure 10: Comparison of initial and final serum urea levels of different groups of volunteers.
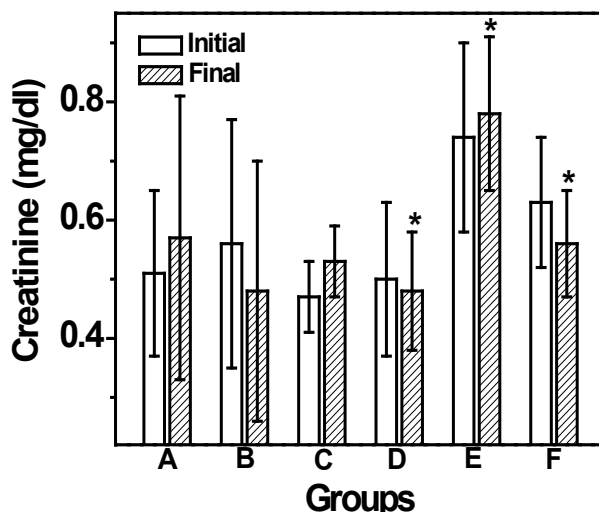

Figure 11: Comparison of initial and final serum creatinine levels of different groups of volunteers.

Discussion

The beedi factory workers are compelled to stay for a long working hours in the factory where the nicotinic environment affects their health. Under weight, anemia and skin irruption were very common among the workers who participated in the study. Some of the workers were also suffering from diabetes. It is already reported that nicotine has a definite adverse role on appetite to the smokers [33]. Long time exposure of nicotine dust played an adverse role on the health conditions of the workers as reflected by clinical observations. Lower calorie intake and adverse effect of nicotine thus synergistically reduced the body weight of the nicotine exposed volunteers. Gain of body weight to some extent as noted for the volunteers in group D showed the beneficiary effect of turmeric rhizomes against nicotine.

Experimentally it has been established that nicotine leads to a condition called pre-diabetes, where the body develops resistance
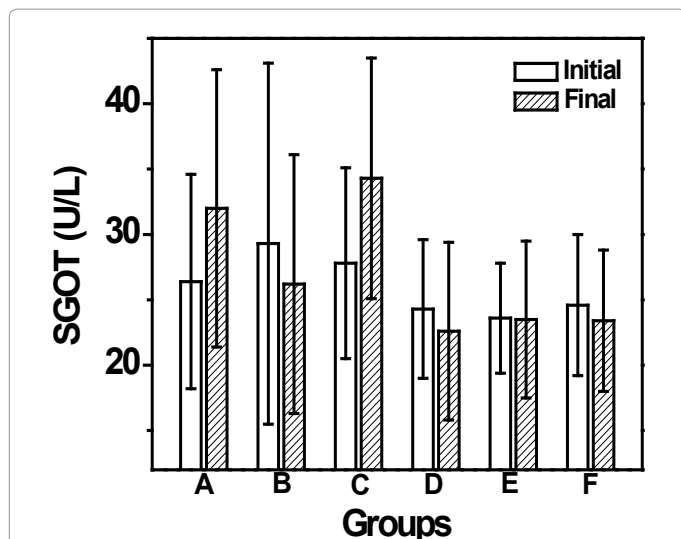
Figure 12: Comparison of initial and final serum SGOT levels of different groups of volunteers.
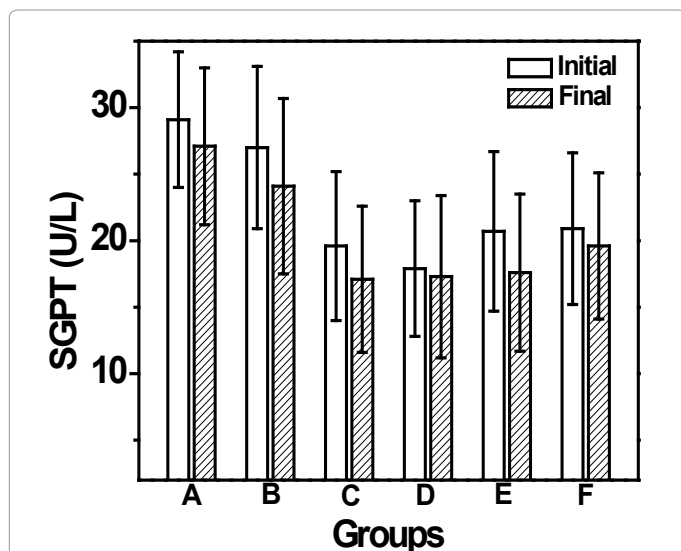

Figure 13: Comparison of initial and final serum SGPT levels of different groups of volunteers.

against insulin causing type 2 diabetes [34]. We had observed that more than 60% volunteers amongst those two beedi factory workers were at pre-diabetic or diabetic condition. The average postprandial blood glucose level of the workers was above 150 mg/dl. Whereas the average postprandial blood glucose levels of the volunteers in control groups (Group A and B) were within normal range. Consumption of raw turmeric rhizomes clearly showed its efficacy by decreasing the postprandial blood glucose levels to those volunteers who consumed it. The reduction of blood glucose level by turmeric rhizome was due to the anti-diabetic activity of curcumin, the colouring pigment of the turmeric as reported earlier [35]. Thus turmeric rhizome may act as one of the useful protective agents against diabetes for the people who are nicotine consumer or under nicotine exposure.

Raw turmeric rhizomes also showed its beneficial effect on normal heart functioning by reducing the pulse rate and blood pressure of the factory workers. Previously, it was noticed that curcumin effectively

ameliorated the nicotine decrement of haemoglobin concentration in the blood and total protein concentration in the serum of nicotine-induced rat [8,20]. This study similarly has established that raw turmeric rhizomes are very much useful in maintaining the levels of blood haemoglobin concentration and total serum protein concentration of the workers against nicotine exposure.

Nicotine enhanced the lipid profile level and lipid peroxidation [20,36]. Lypolysis of adipose tissue was occurred due to the stimulation of catecholamine synthesis by nicotine which increased the serum cholesterol and triglyceride levels [37]. Our investigation revealed that triglyceride and HDL-C levels were reduced by the consumption of raw turmeric, especially for the workers who were under prolonged exposure of nicotine fumes in the factories. Curcumin present in the turmeric mainly acted as a hypo-cholesterolemic agent [38] and lowered the triglyceride level by multiple inductions of fatty acid catabolism [39]. Raw turmeric supplementation also established that it
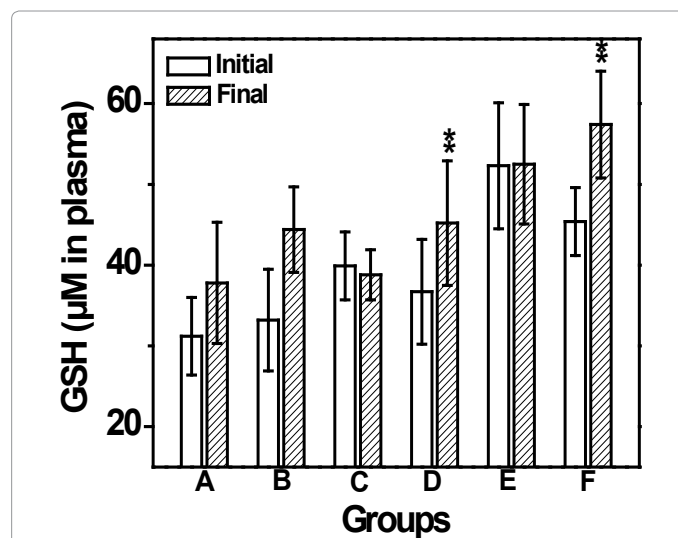

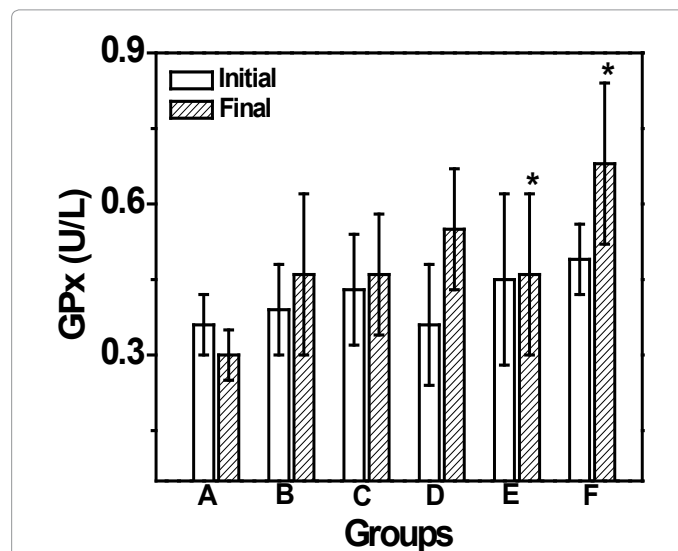**Figure 14:** Comparison of initial and serum GSH levels of different groups of volunteers.

Figure 15: Comparison of initial and final serum GPx levels of different groups of volunteers.
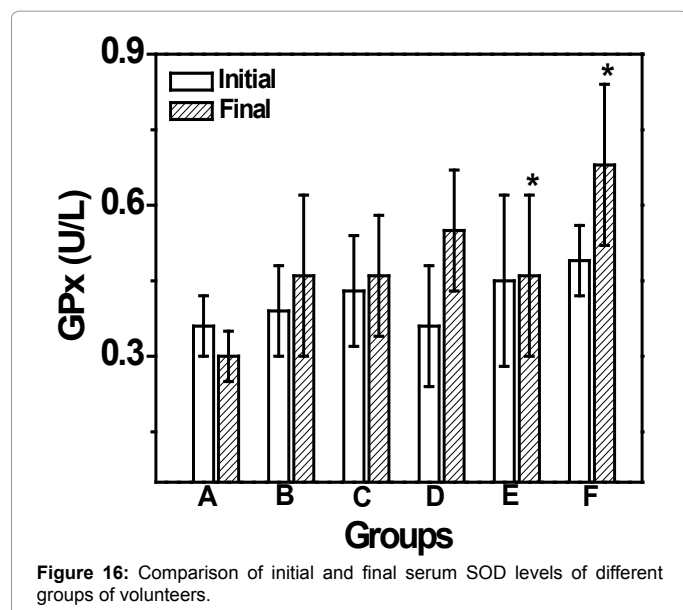
Figure 16: Comparison of initial and final serum SOD levels of different groups of volunteers.

had no adverse effect on kidney and liver functions as the normal levels of urea, creatinine, SGOT and SGPT were maintained to the volunteers who consumed it.

Chakraborty et al. [40] have reported that nicotine induces free radical generation such as superoxide anion and hydrogen peroxide that causes oxidative stress within the cells. Reports say that administration of curcumin significantly lowers the biochemical marker enzymes, inhibits lipid peroxidation [41] and enhances the antioxidant status [42]. Therefore the increased the levels various antioxidant enzymes like SOD, GSH, GP_x in plasma and decreased level of lipid peroxidation as observed to the nicotine exposed and turmeric rhizomes supplemented volunteers corroborate with the results demonstrated earlier. We also observed that the effect was more significant in the case of passive nicotine exposure as compared to active consumption of nicotine. This result suggests that mild exposure to nicotine can be easily compensated by the use of raw turmeric. The tobacco factories workers in general suffer from poor socio-economic condition and cannot afford to spend on different measures to combat the constant exposure to nicotine. Daily consumption of raw turmeric, which is cheaply available in the market, having curcumin as its key extract, will help to maintain and improve their general health conditions.

Conclusion

In this study we have seen that 68.5% of the workers are active consumers of nicotine. Also the workers are deprived of healthy diet due to their poor socio-economic status. The high risk of nicotine toxicity of the beedi factory workers was minimized by the supplemented turmeric rhizomes. Daily consumption of cheaply available raw turmeric rhizomes will at least keep their body fit and maintain their health condition well to some extent. Consumption of raw turmeric rhizomes would be a better therapeutic agent for the long term nicotine exposed people.

Acknowledgement

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