DIETARY ANTIOXIDANTS AND LIPID PROFILE OF SMOKERS

BY

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THESIS

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THIRUVANANTHAPURAM

2002

DECLARATION

I hereby declare that this thesis entitled **"Dietary antioxidants and lipid profile of smokers"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Vellayani,
14 - 8 -2002

Preethi. N.R

CERTIFICATE

Certified that this thesis entitled **"Dietary antioxidants and lipid profile of smokers"** is a record of research work done independently by Ms. Preethi. N.R (99-16-03) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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2.1 Ill effects of free radicals

Free radicals are atoms or groups of atoms that have at least one unpaired electron, which makes them highly reactive. According to Halliwell and Gutteridge (1989); Halliwell (1996), a free radical can be any atom or molecule that contains one or more unpaired electrons in its outermost orbital, which is energetically very unstable. Free oxygen radicals, potentially toxic to cell membranes are produced during various infections.

Free radicals promote beneficial oxidation that produces energy and kills bacterial invaders. Das (1998) reported that free radicals disrupt the equilibrium of biological systems by damaging their major constituent molecules leading eventually to cell deaths. The examples of free radicals are hydrogen, superoxide, singlet oxygen, peroxyl and alkoxyl radicals, trichloromethyl, nitric oxide and nitrogen dioxide.

contains approximately one quadrillion radicals per puff (Rahman and Mac Nee 1996). The reactive oxygen species in the tar phase can react with oxygen to produce the superoxide radical.

Tobacco smoke through its many carcinogens produces harmful free radicals. It enhances the process of lipid peroxidation in the body, which is a complex chemical as well as biochemical reaction involving free radicals, oxygen, metal ions and a number of other factors (Jadhav et al., 1996).

Das (1998) reported that free radicals disrupt the equilibrium of biological systems by damaging their major constituent molecules leading eventually to cell death.

To fight against the detrimental effects of free radicals, our body has several defence mechanisms and the most important among them is antioxidants. Antioxidants control these dangerous effects by scavenging the free radicals or by breaking the chain process of lipid peroxidation.

Certain antioxidants, such as glutathione peroxidase, superoxide dismutase and catalase are present in our body while vitamin E, vitamin C and β-carotene and several other food antioxidants are to be supplied through the diet. Jerman (2000) observed that smokers tend to eat less foods rich in protective antioxidants, eat more high fat foods and drink more alcohol. In addition to their poorer eating habits compared with non-smokers, smokers have depleted levels of antioxidants in their bodies as a result of breathing in cigarette smoke.

People who smoke often have deficiencies in numerous nutrients and essential fatty acids and this results in a depleted antioxidant defence system of the body which enhances the deleterious effects of smoking. A survey of literature clearly indicated that there are only very few attempts made to study the effect of smoking on the dietary intake of antioxidants.

So this study is an attempt to ascertain the dietary intake and serum level of antioxidants on the blood lipid profile of smokers.

Review of Literature

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2.1 Ill effects of free radicals

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Free radicals promote beneficial oxidation that produces energy and kills bacterial invaders. Das (1998) reported that free radicals disrupt the equilibrium of biological systems by damaging their major constituent molecules leading eventually to cell deaths. The examples of free radicals are hydrogen, superoxide, singlet oxygen, peroxyl and alkoxyl radicals, trichloromethyl, nitric oxide and nitrogen dioxide.

Halliwell *et al.* (1995) opined that Reactive Oxygen Species (ROS) as a collective term used to include oxygen radicals like singlet oxygen, hydroxide, superoxide and several non-oxidizing agents such as H_2O_2 and ozone.

Evans and Halliwell (1999) revealed that reactive oxygen and nitrogen species are produced in the human body in both health and disease. The authors also reported that oxidative stress arises when there is a marked imbalance between the production and removal of reactive oxygen and nitrogen species. This may originate from an over production of these substances or from a depletion in the antioxidant defences. Certain drugs may induce oxidative stress by forming drug-derived radicals that cannot deplete the antioxidant defense, but can react directly with biomolecules.

Simone (1998) observed that cigarette smoking increases oxygen free radicals directly and by smoke induced inflammatory responses, which include an increased number of white blood cells, particularly the neutrophils, which in turn, generate large amounts of reactive oxygen species.

Free radical related diseases

According to Maxwell (1995) increased quantities of oxidized metabolites of biomolecules in lipid, protein, DNA has been detected in patients with a variety of diseases. Aruoma (1994) pointed out these diseases include atherosclerosis, coronary heart diseases, diabetes mellitus, rheumatoid arthritis, cancer, stroke, parkinson's disease, alzheimer's disease, hypertension, cataract, malaria and AIDS.

Horvath *et al.* (1992) reported that industrial pollution of the environment has a worsening effect in diseases with a free radical mechanism.

According to Jadhav *et al.* (1996) lipid peroxidation is a very complicated chemical and biochemical reaction involving free radicals, oxygen, metal ions and a number of other factors. In biological systems, lipid peroxidation can occur mainly in biomembranes where the content of unsaturated fatty acids is relatively high.

Allard *et al.* (1994) observed that lipid peroxidation is significantly higher in smokers than in non-smokers. Davies (1996) stated that the collective ill effects of lipid peroxidation on cellular process has been complicated as the underlying mechanism for numerous pathological conditions. Hall (1997) opined that the bio-physical consequences of peroxidation on membrane phospholipids can be both extensive and highly destructive. Anderson *et al.* (1997) and Miller *et al.* (1997) reported that cigarette smokers have higher rates of *in vivo* and *in vitro* lipid peroxidation.

The study confirmed the hypothesis that the atherogenic effects of smoking are mediated in part of free radical damage to lipids. Romero *et al.* (1998) reported that lipid peroxidation is a free radical related process in biological systems that may occur under enzymatic control or non-enzymatically. The authors also stated that this later form is associated mostly with cellular damage as a result of oxidative stress, which also involves cellular antioxidants.

A study conducted by Rabl *et al.* (1993) investigated the hypothesis that ischaemia reperfusion damage in kidney transplantation is associated with lipid peroxidation and that inhibition of lipid peroxidation by antioxidants improves the function of the transplanted kidney. Chung (1994) studied the inhibitory effects of vitamin E on the oxidative damage to cellular lipids and proteins produced during free radical reactions induced by ferric chloride and ascorbic acid. The author reported that lipid peroxidation rates and protein peroxidation in liver of rats given vitamin E were significantly lower than controls. Bland (1995) observed that antioxidants help to defend against cellular lipid peroxidation and lipofusion and ceroid formation.

2.2 Influence of active smoking on health

Smoking is one of the biggest health hazards today. The scientific evidence of the dangers of smoking is tremendous. The Food and Agricultural Organisation of United Nations estimates that tobacco consumption in developing nations has increased at a rate of 2.1 per cent annually during 1985-90 and it is increasing at a rate of 1.9 per cent during 1995-2000 (Barnum, 1994). According to the World Health Organisation (WHO) (1996) there are about 1.1 billion smokers worldwide of which, about one third of the population 15 years and older. Seven hundred million of these smokers are new. In China, 63 per cent of men and 3.8 per cent of women are current smokers (Wong, 1997).

Peto (1996) observed that the total number of deaths caused by tobacco was more than 1.8 million in 1990 and is expected to reach 20 million during the last decade of this century. However, the rate of increase in the epidemic of smoking caused mortality is slowing somewhat among men, but continues to increase rapidly among women in the industrialized world (WHO, 1996). Murray and Lopez (1996) reported that within 25 years, tobacco will surpass infectious diseases to become the leading threat to human health worldwide.

In a study conducted by Public Health Service (1979), fatal dangers of smoking cigarettes have been observed. Nakayama (1985) reported that tobacco smoke through its many carcinogens produces harmful free radicals, which have been shown to change the DNA. Over half a billion people alive today including 200 million currently under the age of 20, will die from tobacco induced disease and half of these will be in middle age (Lancet, 1990).

US Department of Health and Human Services (1989) reported that smoking is now identified as a major cause of heart disease, stroke, several different forms of cancer and a wide variety of other health problems. Giles (1991) indicated that around one-third of all cancer deaths in Australia can be attributed to smoking.

Peto *et al.* (1992) concluded that tobacco was responsible for 1.7 million deaths in 1985 and will cause a projected 2.1 million deaths in 1995. The authors also reported that more than half of these deaths will be among those aged between 35 and 69, making tobacco the largest single cause of premature death in the countries.

The hazards of prolonged cigarette are even greater than used to be supposed. Peto *et al.* (1994) reported that if cigarette smokers commence smoking as teenagers and do not quit, then eventually about half of them will be killed by tobacco, in middle or old age.

Health effects of younger smokers

According to Holman *et al.* (1988) cancer may begin to occur in people aged in their 30s, if they have been smoking for 15-20 years. Even smoking one cigarette causes changes in heart rate. US Department of Health and

Human Services (1988) reported that the nicotine in cigarettes causes changes in heart rate, rise in blood pressure and slowing the peripheral blood circulation resulting in lowered skin temperature.

Addiction to nicotine can occur at an early age and young people have reported withdrawal symptoms and difficulty in quitting (Harper, 1992). Mc Gill *et al.* (1997) observed that the carbon monoxide inhaled when a cigarette is lit has a number of toxic effects on the body, the most immediate of which is its impairment of oxygen transportation in the blood. The authors also reported that smoking is associated with more extensive fatty streaks and raised lesions in the abdominal aorta of this age group.

A study conducted by US department of Health and Human Services (1984) revealed that toxic chemicals in cigarette smoke damage the lung capacity and clearance function, leading to increased coughs and respiratory infections among smokers. They had also reported that adolescent smokers cough more than adolescent non-smokers and by the time they reach young adulthood, a substantial proportion of them will have abnormal changes in the cellular structure of their small airways and experience more asthma and allergic symptoms than non-smokers of the same age. Smith *et al.* (1992) indicated that smokers on average suffer poorer health and are likely to miss school or work due to illness.

Impact of smoking during pregnancy

Smoking affects fertility in females. According to Baird *et al.* (1985) it took 50 to 70 per cent larger for female smokers to conceive than it did for female non-smokers. Smoking affects the well being of the foetus and the pregnant women. US Department of Health and Human Services (1988) reported that nicotine, carbon monoxide and other toxic constituents of tobacco smoke cross the placenta readily, having a direct effect on the oxygen supply to the foetus and the structure and function of the umbilical cord and placenta. The author also stated that nicotine is also found in the breast of women who smoke and has a direct effect on foetal heart rate and breathing movements.

Stergachis *et al.* (1991); Coste *et al.* (1991) opined that smokers have a higher risk of ectopic pregnancy and have a greater tendency to deliver pre-term. Davis (1991) stated that exposure by the mother to workplace passive smoking and paternal smoking has been associated with lower birth weight, a higher risk of perinatal mortality and spontaneous abortion, particularly in the second trimester of pregnancy.

Maternal smoking exerts a direct growth retarding effect on the foetus, resulting in a decrease in all dimensions including length and circumference of chest and head. According to Haglund and Cnattingius (1990); Southall and Samuels (1992); Schoendorf and Kiely (1992), smoking during pregnancy and in the infant's first year of life is considered one of the major risk factors for sudden infant death syndrome.

John *et al.* (1991) revealed that there may be an association between paternal smoking and brain cancer. Millberger *et al.* (1996) reported a strong and significant positive association between cigarette smoking during pregnancy and hyperactivity disorder in their children. Kysinski (1997) found an association between maternal cigarette smoking during the first trimester of pregnancy and increased risk of having a child with cleft lip/palate.

Smoking and cardiovascular disease

Smoking is a major avoidable risk factor for cardiovascular disease. Pic (1981) stated that a majority of a group of men under 35 years old who smoked. more than 30 cigarettes a day had heart attacks immediately after vigorous exercise. Wolf (1988) indicated that cigarette smoking has been shown to be a major risk factor in men and women especially in middle age. Gaziano and Hennekens (1992) estimated that of total coronary heart disease deaths, 24 per cent in men and 11 per cent in women are due to smoking. According to Mezzetti *et al.* (1995) cardiac arrhythmias are mainly caused by the generation of free radicals.

Smoking has been documented as a single health habit that contributes significantly to various preventable chronic diseases including heart disease. Male smokers were at three times the risk of heart disease than non-smokers (Wang and Roe, 1994).

It was found that atherosclerosis begins in childhood and progresses from fatty streaks to raised lesions in adolescence and young adulthood. Smoking is associated with more extensive fatty streaks and raised lesions in the abdominal aorta of this age group (Harper, 1992).

Deaths from cardiovascular disease attributable to cigarette smoking in the United States are estimated to be more than 150,000 per year as cited by the US Department of Health and Human Services (1989).

More deaths and physical suffering are related to cigarette smoking than to any other single cause. Simone (1998) reported that over 228,700 deaths each year occur due to cancer and over 325,000 deaths from cardiovascular disease and more than 50,000 deaths from chronic lung disease.

Smoking and cancer

Cigarette smoking is the major risk factor for lung cancer in both men and women. Spitz *et al.* (1991) observed that smoking accounts for about 30 per cent of all cancer deaths. It was found to be the cause of 85 per cent of all cases of lung cancer.

Hopkin (1991) reported that people who smoke low-tar cigarettes are at higher risk for particularly deadly lung cancer called adenocarcinoma, possibly because these smokers inhale deeper, bringing particles to the smallest and most vulnerable tissues in the lungs.

Cigarette tar found in the lungs of smokers can cause DNA damage that is particularly difficult for the cell to repair. Even after quitting smoking, long term smokers may have permanent cellular change in the lungs that cause a persistent risk for years, even decades. Smokers also have higher rates of leukemia, cancer of the kidney, bladder and pancreas (Parkin *et al.*. 1988).

Smoking and the immune system

According to Simone (1998) smoking causes an increase in macrophage that defend the lung against invading organisms and abnormal cells. The author also reported that macrophages secrete enzymes and other cellular products against the invaders which also inadvertently causes emphysema, the breakdown of the walls of the respiratory tree and generate free radical chemicals, which are responsible for the breakdown of the walls.

Ginns *et al.* (1982) stated that smoking has been shown to cause reversible changes in the immunoregulatory T-cell lymphocytes. Suppressor T-cell activity is significantly enhanced by smoking (Ngymen and Keast, 1986).

Hersey (1983) reported that smokers show a significant decrease in natural killer cell activity. Antibody levels are also adversely affected by smoking (Burrows *et al.*, 1983). Mesharry *et al.* (1985) indicated that IgA, the antibody in the mucous membranes is decreased in smokers.

2.3 Influence of passive smoking on health

Hackshaw *et al.* (1997), in an analysis at 37 published epidemiological studies and the risk of lung cancer in non-smokers who did and did not live with a smoker, found compelling confirmation that breathing other people's tobacco smoke is a cause of lung cancer. The recent report of UK government's Scientific Committee on Tobacco and Health (SCOTH) concluded that passive smoking is a cause of lung cancer and that in those with long term exposure, the increased risk is 20- 30 per cent. It also concludes that passive smoking is a cause of ischaemic heart disease, of serious respiratory illness, asthmatic attack and middle ear disease in children and of the sudden infant death syndrome (Paul, 1998).

Kawachi (1997) observed that healthy, non-smoking women who reported regular exposure to passive smoke at home or in the work place had a 91 per cent greater relative risk of heart attack than those who reported minimal passive smoke exposure. Those who reported occasional exposure had a 58 per cent greater relative risk.

It has been postulated that passive smoking causes more frequent and more severe attacks of asthma in children who already have the disease and may increase the number of cases of asthma among children who have not had previous episodes and this hypothesis was confirmed by Chilmonczyk *et al.* (1993). It is estimated that children exposed to environmental tobacco smoke are about 40 per cent more likely to suffer from asthma symptoms compared to children who are not exposed (National Health and Medical Research Council of Australia, 1997).

Reports of Harper (1992) concluded that children of parents who smoke or inhale nicotine is equivalent to their actively smoking 60–150 cigarettes per year and that, infants of parents who smoke are twice as likely to suffer from serious respiratory infection. It was also observed that, children of parents who smoke more than 10 cigarettes per day are shorter than children of non-smokers. Passive smoking during childhood pre-disposes children to developing chronic obstructive air way disease and cancer in adults.

In the above report, it has been estimated that children exposed to environmental tobacco smoke during the first 18 months of life have a 60 per cent increase in the risk of developing lower respiratory illnesses such as croup, bronchitis, brochiolitis and pneumonia. The report also confirmed the impact of passive smoking on coronary diseases, lung cancer and sudden infant death syndrome.

Couriel (1994) reported that passive smoking is the most common indoor environmental pollution to which children are exposed. A non-smoker who is exposed to tobacco smoke from other smokers has many adverse reactions and is unjustly and unnecessarily subjected to risk factors detrimental to his or her health. The smoke that comes from the lighted end of a cigarette contains more hazardous chemicals than does the smoke that is inhaled by the smokers. Simone (1998) in his study reported that passive smoking causes lung cancer in children. It also causes other respiratory diseases, cardiovascular diseases and also allergies among non-smokers. According to Valkonon and Kuusi (1998) passive smoking caused an acute decrease in serum ascorbic acid, decreased capacity of Low Density Lipoprotein (LDL) and increased amounts of lipid peroxidation end products in serum.

2.4 Micronutrients as antioxidants

Antioxidants may be defined as substances whose presence in relatively low concentrations significantly inhibits the rate of oxidation of the target within the biological system. According to Rabl *et al.* (1993) antioxidative treatment by vitamins could be an important regimen in the reduction of reperfusion damage.

In a study conducted by Postaire *et al.* (1995) the effect of vitamin E, vitamin C and β-carotene upon singlet oxygen protection in erythrocytes of subjects revealed that supply of β-carotene (15-30 mg/day) involved an increase of singlet oxygen protection of erythrocytes.

The association between the plasma antioxidant vitamin levels in health and disease was studied by Singh *et al.* (1995). Reduced vitamin E levels were found in subjects with cardiovascular diseases, stroke, Parkinson's disease and chronic renal failure.

Vitamin E

Vitamin E is the most important, fat soluble antioxidant present in human tissues and plasma (Burton *et al.*, 1983). Meagher *et al.* (2001) reported that vitamin E supplementation is helpful in controlling lipid peroxidation *in vivo*. Among the different tocopherols, α-tocopherols has the highest vitamin E activity.

According to Van Acker (1993) α-tocopherol is considered to be the major membrane bound antioxidants employed by the cell. Yano and Ichikawa (1993) opined that vitamin E had an enhancing effect on active oxygen generation. Zanetti and Catala (2000) reported that vitamin E has a protective effect on oxidative damage in liver mitochondria.

Vitamin E has inhibitory effects on the oxidative damages of cellular lipids and proteins produced during free radical reactions. In a study conducted by Rokitzki *et al.* (1994) it was found that supplementation of vitamin E reduces malondialdehyde serum concentrations. The authors also emphasizes the protective effect of α-tocopherol supplementation against oxidative stress induced by strenuous exercise.

Kumar *et al.* (1992) studied the protection of vitamin E against exercise induced oxidative stress and was correlated with its multi various activities such as scavenger of free radicals, inhibition of lipoxygenases and reduction of peroxides in association with lipoxygenases. Stampfer (1993) and

Rimm (1993) reported that people who took vitamin E supplements had fewer deaths from heart diseases.

Vitamin C

Vitamin C is a powerful scavenging antioxidant which inhibits lipid peroxidation. Chakrabarty *et al.* (1992) reported that chronic subclinical vitamin C deficiency might result in progressive oxidative damage, which may lead to permanent degenerative diseases in the heart. According to Scott *et al.* (1993) vitamin C is a key antioxidant in human blood plasma and has a clear influence upon the outcome of conditions such as acute pancreatitis in which oxidative stress apparently play a pivotal role.

Rojals *et al.* (1994) indicated that dietary supplementation of vitamin C is able to increase the global antioxidant capacity of the heart tissues.

β-carotene

Bendich (1989) stated that β-carotene is a lipid soluble vitamin A precursor and helps to neutralize singlet oxygen and also act as chain breaking antioxidants (Boileau *et al.*, 1999).

Kurashigae *et al.* (1990) reported that β-carotene act as quenchers of singlet oxygen and other reactive species by absorbing the excited energy of singlet oxygen which may lead to the degradation of the carotenoid molecule, but prevents the degradation of biomolecules. Hennekens (1996) opined that β-carotene acts as an antioxidant and an immune system booster.

Selenium

Neve (1991) and Suadicani (1992) observed that selenium is a protective nutrient against the development of heart and artery disease and those with low levels of selenium have a 70 per cent greater risk of coronary heart than those with normal levels. Stone *et al*. (1994) reported that selenium deficiency increases the plasma LDL cholesterol and VLDL cholesterol levels. According to Clark (1996) selenium is a vital antioxidant which protects and strengthens the immune system by preventing the formation of free radicals and is a cancer-deterring dynamo.

Lehr (1994) opined that selenium protects the heart not only by producing glutathione peroxidase, but by also restricting the body's load of toxic metals such as cadmium, mercury, platinum and lead which causes heart tissue damage. A study conducted by Comstock *et al*. (1997) indicated that 200 μg of selenium was found to reduce the risk of several cancers, including cancer of the prostrate (66 %), Colon (50 %) and lung (40 %) when compared to a group receiving a placebo.

2.5 Interaction between antioxidants and smoking

Antioxidants are substances that work in different ways to protect cells from biochemical damage. Halliwell and Gutteridge (1989) and Halliwell (1990) reported that an antioxidant can be defined as any substance that when present at low concentrations compared to those of an oxidizable substrate significantly delays or prevents oxidation of that substrate.

Nagouchi and Niki (1999) stated that biological antioxidants as compounds that protect biological systems against the potentially harmful effects of processes or reactions that can cause excessive oxidations. The antioxidant selenium, vitamin E, vitamin C and β-carotene were found to be protective for smokers.

A study conducted by Steinberg and Chaid (1998), revealed the effect of daily consumption of a tomato based juice supplemented with vitamin C (600 mg), vitamin E (400 IU) and beta carotene (30 μg) on various indices of lipid peroxidation in smokers. The results showed that an antioxidant supplemented drink can reduce lipid peroxidation and susceptibility of LDL oxidation in smokers and may ameliorate the oxidative stress of cigarette smoke.

Hininger *et al.* (1997) conducted a study to find out the effect of increased fruit and vegetable intake on the susceptibility of lipoprotein to oxidation in smokers. After two weeks of increased intake of fruits and vegetables, the circulating levels of carotenoids increased in smokers by 23 per cent and 11 per cent in non-smokers. The study also indicated that an increased carotenoid rich food intake, through its inhibiting effect on the susceptibility of LDL to oxidation reduce the risk of atherosclerosis both in smokers and non-smokers.

Anderson *et al.* (1997) found that vitamin C supplementation caused a statistically significant increase in plasma vitamin C concentrations and total antioxidant capacity in smokers.

The effect of four weeks of pharmacological supplementation with vitamin C (1 g/day) on copper induced LDL oxidation and lipid perodxidation was assessed by Wen *et al.* (1997). The study revealed that vitamin C did not alter LDL oxidation but it may have a protective role against lipid peroxidation.

Results of studies conducted by Frei *et al.* (1991) support the concept of increased vitamin C utilization in smokers and suggest that lipid peroxidation induced by oxidants present in the gas phase of cigarette smoke leads to potentially atherogenic changes in lipoproteins.

Preston (1991) reported that smoking lowers the levels of vitamin C and β-carotene in plasma. According to Princen *et al.* (1992) plasma levels of vitamin C and concentrations of β-carotene and total carotenoids in plasma of smokers were significantly lower when compared to non-smokers.

Jendryczko (1993) indicated that the erythrocytes of children of smoking parents had an increased tendency to peroxidize *in vitro* as compared with those of non-smoking parents. The author also reported that sustained oxidant stress in children of smoking parents were partially ameliorated by vitamin E supplementation.

In a study conducted by Mezzetti *et al.* (1995) among 24 smokers and 24 non-smokers revealed that tissue vitamin E and C levels were significantly lower and lipid peroxide plasma levels were higher in smokers than in non-smokers.

Brown *et al.* (1997) reported that male smokers form a Scottish population with habitually low vitamin E and vitamin C intakes, consistently had lower plasma ascorbate concentration and greater susceptibility to hydrogen peroxide stimulated erythrocyte peroxidation *in vitro* than did non-smokers from the same population.

A study was conducted by Do *et al.* (1996) to determine the effect of antioxidants on lipid peroxidation. Smokers were given 6 mg β-carotene, 200 IU vitamin E and 250 mg vitamin C, four times a day for three weeks and found that ethane production correlated with active (packs/day) and life long (pack/year) tobacco consumption. The authors also reported a decline in ethane output after micronutrient supplementation.

The effect of ascorbate depletion and supplementation on the propensity of LDL to oxidize in smokers was studied by Fuller *et al.* (1996) and found that the ascorbate supplemented group had significant increase in plasma ascorbate whereas the placebo group showed no change in the LDL oxidation between 0 and 4 weeks.

According to Lapenna *et al.* (1995) cigarette smoke related plasma oxidant load may be partly due to enhanced levels of pro-oxidant metal copper, potentially suggesting the supplementation of specific antioxidants (Zinc) to counteract cigarette smoke induced oxidative stress in smokers.

Gladston *et al.* (1984) indicated that cigarette smoking can cause partial inactivation of serum antioxidants activity accompanied by insufficient compensatory increase in ceruloplasmin concentration and that ceruloplasmin may protect the lung against oxidants in cigarette smoke and air pollutants. Harats *et al.* (1990) stated that acute smoking exerts an oxidative stress on plasma lipoproteins and that higher plasma levels of natural antioxidants such as vitamin C and E have a protective role. Faruque *et al.* (1995) reported the plasma vitamin C level of smokers was significantly lower than that of non-smokers. Singh *et al.* (1996) suggested that combined treatment with antioxidant vitamins A, E, C and β-carotene in patients with recent acute mycocardial infarction may be protective against cardiac necrosis and oxidative stress and could be beneficial in preventing complications and cardiac event rate in such patients.

An investigation for three weeks on the peroxidase potential of plasma among 12 healthy women revealed an improvement in plasma concentrations of β, α and γ carotene and a free supplementation increases the plasma antioxidant capacity (Meydani *et al.*, 1994). A study conducted to quantify the major carotenoids in plasma of habitual smokers revealed significant variations in alpha carotene, β-carotene and cryptoxanthins when compared to non-smokers. Lower carotenoid concentrations may be due to either deficient dietary patterns or due to increased metabolic turn over (Ross *et al.*, 1995).

2.7 Dietary habits of smokers

The dietary habits of smokers were found to be very poor when compared with that of non-smokers. Wang and Roe (1994) reported that the intake of dietary fibre and a number of minerals and vitamins, notably vitamin C are lower in smokers than non-smokers.

According to Gonzalez *et al.* (1997), heavy smokers were more likely to have a higher intake of eggs, whole milk, pork, fried foods and legumes. Light smokers were less likely to have a higher intake of fruit than non-smokers. The author opined that heavy smokers showed a less healthy dietary profile than both light smokers and non-smokers.

Handelman *et al.* (1996) observed that people who smoke often have deficiencies in numerous nutrients, including zinc, calcium, folate, vitamin C, vitamin E and β-carotene, lycopene and essential fatty acids.

The health implications of smoking are enhanced by poor diet which in turn negatively affects the human antioxidant defence system (Sulsky *et al.*, 1990).

Frei *et al.* (1991), opined that smokers use the body reserves of antioxidants to detoxify, the humongous levels of free radicals, which are being produced by the cigarette smoke, therefore resulting in a deficiency of different antioxidants. Therefore, a supplementation of antioxidants such as vitamin E, vitamin C, β-carotene etc., can enhance the antioxidant defence system thus reducing the deleterious effect of smoking.

Materials and Methods

3. MATERIALS AND METHODS

The study entitled 'Dietary antioxidants and lipid profile of smokers' is a comprehensive study carried out with an objective to measure the dietary intake and serum levels of antioxidants on the blood lipid profile of smokers.

Data pertaining to the study are generated by ascertaining:

3.1 Socio-economic profile of the respondents

3.2 Dietary profile of the respondents

3.3 Anthropometric measurements of the respondents

3.4 Smoking habits of the respondents

3.5 Influence of smoking on nutritional status and serum profile of lipids and antioxidants (in-depth study)

3.6 Statistical methods

Selection of subjects

One hundred adult male smokers fulfilling the following criteria (as detailed in Appendix-I) were selected for the study.

Inclusion criteria

(i) Age group of 30 years and above

(ii) In the habit of smoking for 10 years or more with a minimum of 10 (filtered or unfiltered) cigarettes a day.

Exclusion Criteria

(i) Presence of metabolic or functional diseases

(ii) Habit of taking multivitamin tablets

(iii) Alcoholics

3.1 Socio economic profile of the respondents

According to Arora (1991), the socio economic profile of an individual with reference to socio economic status and family background in general have a very distinct part to play in determining their attitude and behavioural patterns.

Nutritional status is an indicator of social well being of a community. Nutritional status is influenced by factors such as psychological, socio-cultural and physiological conditions. A pre-tested schedule to assess the socio-economic status of the family with reference to the income, size, type and composition of the families of respondents pertaining to their age. educational status, occupation and marital status was administered for eliciting the required information. The details are given in Appendix II.

3.2 Dietary profile of the respondents

Diet surveys constitute an essential part of any study on nutritional status of individual or groups, providing essential information on nutrient intake levels, sources of nutrients, food habits and food behaviour pattern. Through the pre-tested schedule, information on frequency of use of foods rich in antioxidants was also collected. Details are given in Appendix III and IV.

For generating information on socio economic and dietary profile, house visits, interviewing and observation methods were attempted.

3.3 Anthropometric measurements of the respondents

Nutritional anthropometry is the measurement of human body at various ages and levels of nutritional status and it is based on the concept that an appropriate measurement should reflect any morphological variation occurring due to a significant functional physiological stage.

According to Gorstein *et al.* (1994) anthropometry is widely used as a tool to estimate the nutritional status of populations and to monitor the growth and health of individuals.

The anthropometric measurements recorded were height, weight, hip and waist measurements, and mid upper arm circumference and skin fold thickness at triceps.

Height of the respondents were recorded using a stadiometer employing the technique suggested by Jelliffee (1966).

Weight was measured using a beam balance to an accuracy of upto 0.1 kg (Jelliffee, 1966).

Plate - I
Measurement of MUAC

Plate - II
Waist Measurement

Plate - III
Hip Measurement

Plate - IV
Food Weighment

Bodv Mass Index (BMI) were computed from the recorded height and weight of the subjects by using the formula $BMI = \frac{\text{Weight (kg)}}{\text{Height}^2\ (m^2)}$, since body mass is an indicator of general obesity and gives the magnitude of protein calorie malnutrition (James *et al.*, 1988).

The Mid Upper Arm Circumference (MUAC) was recorded using the technique suggested by Jelliffee (1966) (Plate 1).

Waist and hip circumferences were measured as recommended by Chadha *et al.* (1995) (Plates 2 and 3).

The skin fold thickness was determined using a fat caliper as per the technique suggested by Jelliffee (1966) (Details of anthropometry are given in Appendix V).

3.4 Smoking habits of the respondents

The smoking habits of the respondents were studied with reference to :

3.4.1 Frequency of smoking of the respondents

Frequency of smoking of the respondents was recorded using an inventory schedule for a period of seven days (Appendix VI and VII).

3.4.2 Visual observation

Visual observation related to heavy smoking such as stained fingers, stained teeth and black lips were also recorded by observation.

3.5 Influence of smoking on nutritional status and serum profile of lipids and antioxidants (in-depth study)

An in-depth study was conducted to analyse the influence of intensity of smoking on nutritional status and serum profile of lipids and antioxidants on selected respondents.

Selection of respondents

Based on the intensity of smoking and dietary deficiency of antioxidants, a sub sample of 20 subjects were selected for in-depth study.

The investigations included the assessment of actual food intake and estimation of serum profile with reference to antioxidants such as vitamin E, and β-Carotene and also the lipid profile including total cholesterol, HDL-C, LDL-C and triglycerides along with haemoglobin and albumin content in the serum.

3.5.1 Assessment of Actual food intake

Since weighment method can give accurate values of dietary intake, a single day food weighment survey was carried out among all the 20 subjects using the schedule presented in Appendix VIII. All the raw foods taken by the family for cooking were weighed. The foods consumed by the individual and its remaining after eating were also weighed and recorded to find out the exact amount of foods consumed by them.

The nutritive value of the foods consumed was calculated using the Food Composition Table (Gopalan *et al.*, 1990), and the major nutrients such as protein, carbohydrates, fat and energy; vitamins like vitamin E, vitamin C and β-carotene and minerals such as iron and calcium were worked out of the diet and were compared with Recommended Dietary Allowances (RDA) of ICMR (1989) (Plate 4).

3.5.2 Biochemical investigations on serum profile

The different biochemical investigations carried out in the present study are detailed in Table 1.

Table 1. Biochemical investigation on serum profile

Sl. No	Variables	Methods followed
1	Triglycerides	Foster and Dann (1973)
2	Total cholesterol	Henley (1957)
3	HDL-C or High Density Lipo protein -Cholesterol	Lopes - Vivella *et al.* (1977)
4	LDL-C or Low Density Lipo protein-Cholesterol	Friedwald (1972)
5	Vitamin E	Milne and Botnan (1986)
6	β - Carotene	Milne and Botnan (1986)
7	Haemoglobin	Cyan methaemoglobin method
8	Albumin	Bromocresol green method

3.6 Statistical methods

The data collected were analysed by appropriate statistical techniques viz., frequency distribution, percentage analysis, mean, Standard Deviation, correlation analysis and chi square analysis.

Results

4. RESULTS

Results generated under this study entitled Dietary antioxidants and lipid profile of smokers are presented under the following sections.

4.1. Distribution of respondents based on personal and demographic characteristics

4.2. Distribution of respondents based on Smoking Index and their socio economic, dietary and anthropometric profiles

4.3. In-depth study on selected respondents

4.1 Distribution of respondents based on personal and demographic characteristics

Distribution of smokers based on the variations in personal characteristics like age, educational status, occupation and marital status and influence of these characteristics on the number of cigarettes used daily by the respondents are detailed in Table 2.

As revealed in the Table, 61 per cent of the respondents surveyed were found to be in the habit of smoking 10 to 15 cigarettes per day, while only 14 per cent were found to smoke more than 30 cigarettes per day. Remaining 25 per cent of the respondents were found to be distributed as persons smoking 16 to 20 (13 per cent), 21 to 25 (9 per cent) and 26 to 30 (3 per cent).

Table 2 Distribution of smokers based on the variations in personal characteristics

N = 100

Particulars	Variations in number of cigarettes used daily					Total
	10–15	16–20	21–25	26–30	> 30	
Age						
30–35	16	2	3	2	1	24
36–40	16	6	2	1	7	32
41–45	5	1	-	-	2	8
46–50	8	4	-	-	2	14
51–55	11	-	1	-	1	13
56–60	3	-	1	-	1	5
>60	2	-	2	-	-	4
Total	**61**	**13**	**9**	**3**	**14**	
Educational status						
Illiterate	1	1	1	-	-	3
LPS	5	-	-	-	-	5
UPS	6	1	1	2	3	13
HS	28	7	6	-	6	47
Pre-Degree	12	2	1	1	3	19
Degree	9	2	-	-	2	13
Total	**61**	**13**	**9**	**3**	**14**	
Occupation						
Sedentary	24	5	4	2	3	38
Moderate	16	3	3	1	6	29
Heavy	21	5	2	-	5	33
Total	**61**	**13**	**9**	**3**	**14**	
Marital status						
Married	52	13	9	2	13	89
Unmarried	9	-	-	1	1	11
Total	**61**	**13**	**9**	**3**	**14**	

Twenty four per cent of the respondents were in the age group of 30 to 35 while 32 per cent were in the age group of 36 to 40. Respondents in the higher age groups namely, 41 to 45 (8 per cent), 46 to 50 (14 per cent), 51 to 55 (13 per cent), 56-60 (5 per cent) and 60 above (4 per cent) were found to be less than the above two groups. This distribution also indicates a decline in smoking habits as age advances.

Assessment of the educational status of the respondents revealed that three per cent of the respondents were illiterate while five per cent had the education upto lower primary level. Thirteen per cent of the respondents were observed to have attended upper primary level classes; 47 per cent high school level classes; 19 per cent pre-degree level classes and 13 per cent degree level classes. This distribution also designates an influence of education in the frequency of smoking.

The occupational status of the respondents indicated an exposure of 38 per cent to sedentary jobs, 29 per cent to moderate activities and 33 per cent to heavy physical work. This distribution throws light on the influence of physical work on the frequency of smoking.

Eighty nine per cent of the respondents were observed to be settled in life with families while a comparatively younger age group were found unmarried. This distribution also indicates that frequency of smoking is found not restrained by the marital status.

Table 3 details the distribution of smokers based on the demographic profile of the families and the variations in the frequency of smoking in these different groups.

Twenty eight per cent of the respondents surveyed were found to have an income level of less than Rs 2500 per month, while 30 per cent were in the income range of Rs. 2501 to Rs. 5000. Twenty one per cent of the respondents were identified under the group with a monthly income of Rs. 5001 to Rs. 7500; 16 per cent with a monthly income of Rs. 7501 to 10000 and five per cent in the group with a monthly income more than Rs 10,000.

Ninety two per cent of the respondents belonged to nuclear families and eight per cent were members of joint families.

Analysis of the composition of the families of the respondents revealed that 11 per cent of the families were comprised of three members and 48 per cent of the families were comprised of four members. Five members were observed in 28 per cent of the families, six members in six per cent of families and seven members in seven per cent of the families.

The distribution of respondents in different groups according to the frequency of smoking were not found uniform.

Table 4 details the distribution of respondents classified on the basis of years of smoking and influence the variations in personal characteristics of the respondents on their smoking habits with reference to years of smoking.

Table 3 **Distribution of smokers based on the demographic profile of their families**

N=100

Particulars	Variations in number of cigarettes used daily					Total
	10–15	16–20	21–25	26–30	> 30	
Monthly Income (Rs.)						
<2500	17	9	1	-	1	28
2501 – 5000	23	1	3	2	1	30
5001 – 7500	11	1	4	-	5	21
7501 – 10000	10	1	1	1	3	16
>10000	-	1	-	-	4	5
Total	**61**	**13**	**9**	**3**	**14**	
Type of family						
Nuclear	56	13	6	3	14	92
Joint	5	-	3	-	-	8
Total	**61**	**13**	**9**	**3**	**14**	
Number of family members						
3	6	1	2	1	1	11
4	28	7	4	2	7	48
5	18	3	3	-	4	28
6	5	-	-	-	1	6
7	4	2	-	-	1	7
Total	**61**	**13**	**9**	**3**	**14**	

As revealed in the Table, 36 per cent of the respondents surveyed were found to be in the habit of smoking for 10-15 years, while only 12 per cent of the persons surveyed were found to be smoking for more than 30 years. Remaining 52 per cent of the respondents were found to be distributed as persons in the habit of smoking for 16 to 20 years (30 per cent), 21 to 25 years (9 per cent) and 26 to 30 years (13 per cent).

In the 30 to 35 age group, out of the 24 per cent of the respondents identified 20 per cent were in the smoking habit for the last 10 to 15 years and four per cent for 16 to 20 years. In the 36 to 40 age group, out of 32 per cent identified 12 per cent of the respondents were in the habit of smoking for the last 10 to 15 years; 15 per cent of them for 16 to 20 years; one per cent for 21-25 years, two per cent for 26 to 30 years ,and two per cent for more than 30 years.

In the age group of 41 to 45, one per cent of the respondents were found to be in the habit of smoking for the past 10 to 15 years. While four per cent for 16 to 20 years and three per cent for 21 to 25 years. In the 46 to 50 age group, out of 14 per cent of the respondents two per cent were in the habit of smoking for the past 10 to 15 years. Three per cent for 16 to 20 years, three per cent for 21 to 25 years, five per cent for 26 to 30 years, and one per cent for more than 30 years.

In the 51 to 55 age group, out of the 13 per cent of the respondents surveyed, one per cent was observed to be smoking for the past 10 to 15 years. three per cent for 16 to 20 years, one per cent for 21 to 25 years, three per cent

Table 4 Distribution of respondents based on the variations in personal characteristics

N = 100

Particulars	Variations in number of years of smoking					
	10–15	16–20	21–25	26–30	> 30	Total
Age						
30–35	20	4	-	-	-	24
36–40	12	15	1	2	2	32
41–45	1	4	3	-	-	8
46–50	2	3	3	5	1	14
51–55	1	3	1	3	5	13
56–60	-	1	1	2	1	5
>60	-	-	-	1	3	4
Total	36	30	9	13	12	
Educational status						
Illiterate	-	-	-	1	2	3
LPS	1	1	1	-	2	5
UPS	4	6	2	1	-	13
HS	16	12	4	11	4	47
Pre-Degree	7	10	-	-	2	19
Degree	8	1	2	-	2	13
Total	36	30	9	13	12	
Occupation						
Sedentary	15	8	4	4	7	38
Moderate	10	7	3	4	5	29
Heavy	11	15	2	5	-	33
Total	36	30	9	13	12	
Marital status						
Married	27	29	8	13	12	89
Unmarried	9	1	1	0	-	11
Total	36	30	9	13	12	

for 26 to 30 years and five per cent for more than 30 years. In the 56-60 age group, of the total five per cent, one per cent belonged to the group of those who had been smoking for 16 to 20 years, one per cent for 21 to 25 years, two per cent for 26 to 30 years and one per cent for more than 30 years. In the 'more than 60' age group, one per cent was found to be smoking for 26 to 30 years, three per cent were found to be in the habit of smoking for more than 30 years.

In the case of educational status, 36 per cent of the respondents surveyed were in the habit of smoking for 10 to 15 years, where as 12 per cent for more than 30 years. Three per cent of the respondents were illiterate and was distributed among the groups smoking for 26 to 30 years (1 per cent) and more than 30 years (2 per cent). Out of the five per cent of respondents with lower primary school education, one per cent were smoking for 10 to 15 years, one per cent for 16 to 20 years, one per cent for 21 to 25 years and two per cent for more than 30 years. In the group of the respondents with upper primary school education (13 per cent), four per cent of them were smoking for the past 10 to 15 years, six per cent for 16 to 20 years, two per cent for 21 to 25 years, and one per cent for 26 to 30 years.

In the educational group of respondents (47 per cent) having high school level education, 16 per cent were in the habit of smoking for the past 10 to 15 years, 12 per cent for 16 to 20 years, four per cent for 21 to 25 years, 11 per cent for 26 to 30 years and four per cent for more than 30 years.

In the educational group of respondents with pre-degree level education, (19 per cent), seven per cent belonged to the group of respondents who were smoking for 10 to 15 years, 10 per cent for 16 to 20 years and two per cent for more than 30 years. Among the 13 per cent of the respondents who had degree level education eight per cent were in the habit of smoking for the past 10 to 15 years, one per cent for 16 to 20 years, two per cent for 21 to 25 years and two per cent for more than 30 years. This distribution indicates no association between education level and years of smoking.

The occupational status of the respondents as revealed in the Table indicates that 38 per cent of the respondents were sedentary workers, 29 per cent were moderate workers and 33 per cent were heavy workers. Among the 38 per cent of sedentary workers surveyed, 15 per cent were in the habit of smoking for 10 to 15 years, eight per cent for 16 to 20 years, four per cent for 21 to 25 years, four per cent for 26 to 30 years and seven per cent for more than 35 years. Out of the 29 per cent of the moderate workers surveyed, 10 per cent were in the habit of smoking for 10 to 15 years, seven per cent for 16 to 20 years, three per cent for 21 to 25 years, four per cent for 26 to 30 years and five per cent for more than 30 years. Among the 33 per cent of the respondents surveyed who were heavy workers, 11 per cent were in the habit of smoking for 10 to 15 years, 15 per cent for 16 to 20 years, two per cent for 21 to 25 years and five per cent for 26 to 30 years.

Out of the 89 per cent of the married respondents. 27 per cent of them were in the habit of smoking for 10 to 15 years, 29 per cent for 16 to 20 years eight per cent for 21 to 25 years, 13 per cent for 26 to 30 years and 12 per cent for more than 30 years. Among the 11 per cent of unmarried respondents, nine per cent were with smoking habits for 10 to 15 years one per cent for 16 to 20 years, and one per cent for 21 to 25 years.

Influence of the personal characteristics of the respondents like age, education, occupation, and marital status on smoking pattern were found not complementary.

Table 5 details the distribution of respondents based on the demographic profile of their families according to the number of years of smoking.

Out of 28 per cent of the respondents with a monthly income of less than Rs. 2500, seven per cent were in the habit of smoking for 10 to 15 years, seven per cent for 16 to 20 years, four per cent for 21 to 25 years, six per cent for 26 to 30 years and four per cent for more than 30 years. Out of 30 per cent of the respondents having monthly income of Rs. 2501 to 5000; 12 per cent were in the habit of smoking for 10 to 15 years, 12 per cent for 16 to 20 years, one per cent for 21 to 25 years, one per cent for 26 to 30 years and four per cent for more than 30 years. From among 21 per cent of the respondents with a monthly income of Rs. 5001 to 7500, seven per cent were smoking for the past 10 to 15 years, five per cent for 16 to 20 years, one per cent for 21 to 25 years, four per cent for 26 to 30 years and three per cent for more than 30 years. Out of 16 per cent of the respondents with a monthly income of Rs. 7501 to 10000, seven per cent were smoking for 10 to 15 years. five per cent for 16 to 20 years, two per cent for 21 to 25 years and two per

Table 5 Distribution of respondents based on the demographic profile of their families

N=100

Particulars	Variations in number of years of smoking					Total
	10–15	16–20	21–25	26–30	> 30	
Monthly Income (Rs.)						
<2500	7	7	4	6	4	28
2501 – 5000	12	12	1	1	4	30
5001 – 7500	7	6	1	4	3	21
7501 – 10000	7	5	2	2	-	16
>10000	3	-	1	-	1	5
Total	**36**	**30**	**9**	**13**	**12**	
Type of family						
Nuclear	32	28	8	13	11	92
Joint	4	2	1	-	1	8
Total	**36**	**30**	**9**	**13**	**12**	
Number of family members						
3	2	6	-	2	1	11
4	15	14	5	6	8	48
5	11	9	3	3	2	28
6	4	-	-	2	-	6
7	4	1	1	-	1	7
Total	**36**	**30**	**9**	**13**	**12**	

cent for 26 to 30 years. Out of the five per cent of the respondents with a monthly income of above Rs. 10,000, three per cent were smoking for 10 to 15 years, one per cent for 21 to 25 years and one per cent for more than 30 years.

From among the respondents of nuclear families (92 per cent), 32 per cent were observed to be smoking for 10 to 15 years, 28 per cent for 16 to 20 years, eight per cent for 21 to 25 years, 13 per cent for 26 to 30 years and 11 per cent for more than 30 years. And among the remaining eight per cent in joint families, four per cent were observed to be smoking for 10 to 15 years, two per cent for 16 to 20 years, one per cent for 21 to 25 years and one per cent for more than 30 years.

The family composition of the respondents is also detailed in the Table. Eleven per cent of the respondents were having three members in their families; out of which two per cent were smoking for 10 to 15 years, six per cent for 16 to 20 years, two per cent for 26 to 30 years and one per cent for more than 30 years. Forty eight per cent of the respondents were having four members in their families. Among these, 15 per cent were smoking for 10 to 15 years, 14 per cent for 16 to 20 years, five per cent for 21 to 25 years, six per cent for 26 to 30 years and eight per cent for more than 30 years. Twenty eight per cent of the respondents were having five members in their families. Of these 11 per cent were smoking for 10 to 15 years, nine per cent for 16 to 20 years, three per cent for 21 to 25 years, three per cent for 26 to 30 years and two per cent for more than 30 years.

Six per cent of the respondents were having six members in their families, out of which four per cent were smoking for 10 to 15 years and two per cent for more than 30 years. Seven per cent of the respondents were having seven members in their families, out of which four per cent were smoking for 10 to 15 years, one per cent for 16 to 20 years, one per cent for 21 to 25 years and one per cent for more than 30 years.

Table 6 details the distribution of respondents based on the frequency of selected food items rich in antioxidants like vitamin C, vitamin E, and β-carotene. Green leafy vegetables, roots and tubers, other vegetables, fruits, nuts and oil seeds, flesh foods, milk and milk products and fats and oils were the selected food groups considered in this context. Scores allotted for the frequency of use of foods were 'five' for daily use, 'four' for weekly thrice, 'three' for weekly twice, 'two' for weekly once and 'one' for occasional use. Scores obtained for each food group was worked out by summing up the scores obtained for each food group by every individual respondents. From this data mean score for each food item was worked out by using Reaburn's formula (Appendix IV).

As revealed in the Table, milk and milk products and fats and oils were found to be daily used by all the respondents surveyed with a mean score '100' which is also the maximum score. Least popular foods, based on mean score were flesh foods (55), followed by roots and tubers (66) and nuts and oil seeds (62), since the mean score for these foods were only less than 36 per cent of the maximum score. Foods like other vegetables (91) and fruits (79) were considered as more frequently used foods since the mean score for these

Table 6 Percentage distribution of respondents based on their food use frequency score

Food items	Daily (5)	Weekly – 3 (4)	Weekly – 2 (3)	Weekly – 1 (2)	Occasionally (1)	Mean score
Green leafy vegetables	14	29	34	21	2	66
Roots and tubers	6	36	39	19	-	66
Other vegetables	63	30	6	1	-	91
Fruits	35	35	23	6	1	79
Nuts and oilseeds	16	27	23	20	14	62
Flesh foods	12	19	31	29	9	55
Milk and milk products	100	-	-	-	-	100
Fats and oils	100	-	-	-	-	100

food items were greater than 50 per cent of the maximum score. Among the nine food items studied foods like flesh foods and nuts and oil seeds were occasionally used by nine per cent and 14 per cent of the respondents respectively.

Among the different foods, green leafy vegetables are the richest source of antioxidants. These food items were daily used by 14 per cent of the respondents while consumption of these food items were restricted to thrice a week (29 per cent), twice a week (34 per cent) and once a week (21 per cent) by the respondents. These food items were not very popular among two per cent of the respondents, since these foods made only occasional appearance in their daily diets.

Few roots and tubers like carrot and beetroot are good sources of carotenoids and fair sources of vitamin C. Among the respondents surveyed, only six per cent were in the habit of using roots and tubers daily while 19 per cent of them used them once in a week. The remaining respondents used this food item either weekly twice (39 per cent) or weekly thrice (36 per cent).

Other vegetables like bittergourd, drumstick, cauliflower, beans, mango green, pumpkin, snakegourd, tomato green, field beans and beans were daily used by 63 per cent of the people surveyed, since these food articles form the basic ingredients for most of the Kerala dishes. One per cent of the respondents were in the habit of using these food articles weekly once, six per cent weekly twice and 30 per cent weekly thrice.

Fruits were also observed to be preferred food items of the respondents surveyed. Thirty five per cent of them were in the habit of using fruits daily while only one per cent used these food articles occasionally. Six per cent of the respondents used them weekly once, 23 per cent twice a week and 35 per cent weekly thrice.

Commonly used nuts and oil seeds by the respondents were observed to be ground nut and gingelly seeds. Sixteen per cent of the respondents used any of these food articles daily, while 14 per cent used them only occasionally, 20 per cent of the respondents were habituated to use the food articles once in a week, 23 per cent twice a week and 27 per cent thrice a week.

Flesh foods like mutton, beef and egg were the least consumed food items by the respondents surveyed. Twelve per cent used them daily and nine per cent used them occasionally. It was used weekly once by 29 per cent, weekly twice by 31 per cent and weekly thrice by 19 per cent.

4.2 Distribution of respondents based on Smoking Index and their socio economic, dietary and anthropometric profiles

For developing Smoking Index data generated on frequency of smoking of the respondents was mainly used.

4.2.1 Frequency of smoking of the respondents

Data pertaining to the frequency of smoking of the respondents as well as the number of cigarettes smoked per hour were recorded using an inventory schedule for a period of seven days (Appendix VII). A log book for seven days was given to all the respondents, in which details regarding the day, date, time (in hours) and the number of cigarettes smoked on each hour were recorded. Mean value of number of cigarettes smoked on each hour for seven days as well as the mean total number of cigarettes smoked for seven days were taken.

The results revealed that all the respondents were in the habit of smoking maximum number of cigarettes during the lunch interval of 1.00 to 2.00 P.M., while 90 per cent of respondents were in the habit of smoking more cigarettes during 9.00 to 10.00 A.M. Among the respondents, 85 per cent were smoking more cigarettes during, 6.00 to 7.00 A.M., 11.00 A.M. to 12.00 P.M., 12.00 to 1.00 P.M. and 5.00 to 6.00 P.M. Morning and evening hours like 7.00 to 8.00 A.M, 7.00 to 8.00 P.M. and 8.00 to 9.00 P.M. were found congenial for 80 per cent and before 6.00 A.M., 10.00 to 11.00 A.M., 3.00 to 4.00 P.M., 4.00 to 5.00 P.M. and 6.00 to 7.00 P.M. were found agreeable to 70 per cent of the respondents to smoke more cigarettes. Sixty five per cent were in the habit of smoking during 8.00 to 9.00 A.M., 55 per cent smoking during 2.00 to 3.00 P.M. and 50 per cent smoking after 9.00 P.M.

The data also revealed the approximate number of cigarettes smoked by the respondents per day. The maximum number of cigarettes smoked was 55 (1 per cent) followed by 50 (1 per cent), 48 (1 per cent) and 42 (2 per cent). Other respondents fell in the range of 36 to 40 (2 per cent), 31 to 35 (7 per cent), 26 to 30 (3 per cent), 21 to 25 (9 per cent), 16 to 20 (13 per cent) and 10 to 15 (61 per cent).

Visual observation of the respondents revealed that all the respondents were having black lips, 81 per cent were with coloured teeth and 51 per cent were with stained fingers.

The respondents were distributed according to the Smoking Index developed.

Smoking Index (SI) for each respondent was developed using the formula:-

$$\frac{\text{No. of cigarettes used per day} \times \text{No. of years of smoking}}{\text{Age of the respondent}}$$

It gives an idea regarding the intensity of smoking habit in an individual. Respondents studied were categorized into four groups on the basis of classification as $< \bar{x}^{*} - \sigma^{\otimes}$ (< 2.3, first category), $\bar{x} - \sigma$ (2.4 to 9.0, second category), $\bar{x} + \sigma$ (9.1 to 15.6, third category) and $> \bar{x} + \sigma$ (15.7 to 40.8, fourth category). This classification is followed for the generation of results.

Maximum values for SI was 40.8 and minimum 1.04.

4.2.2 Distribution of respondents based on selected personal characteristics and SI developed

Influence of selected personal characteristics like age, education, occupation, marital status and income of the respondents on SI was assessed and details are presented in Table 7.

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*$\bar{x}$ – Mean
$^{\otimes}\sigma$- Standard Deviation

Table 7 Distribution of the respondents based on their socio-economic profile and SI developed

N=100

Particulars	SI				Total
	<2.3	2.4 – 9.0	9.1 – 15.6	15.7 – 40.8	
Age					
30–35	-	18	5	1	24
36–40	-	23	5	4	32
41–45	-	7	1	-	8
46–50	-	6	6	2	14
51–55	1	9	2	1	13
56–60	-	4	-	1	5
>60	-	1	2	1	4
Total	**1**	**68**	**21**	**10**	
Educational status					
Illiterate	-	1	1	1	3
LPS	1	1	2	1	5
UPS	-	5	5	3	13
HS	-	36	8	3	47
Pre-Degree	-	14	3	2	19
Degree	-	11	2	-	13
Total	**1**	**68**	**21**	**10**	
Occupation					
Sedentary	-	27	8	3	38
Moderate	-	19	6	4	29
Heavy	1	22	7	3	33
Total	**1**	**68**	**21**	**10**	
Marital status					
Unmarried	-	6	5	-	11
Married	1	62	16	10	89
Total	**1**	**68**	**21**	**10**	
Monthly income(Rs.)					
<2500	1	19	5	3	28
2500 – 5000	-	23	5	2	30
5001 – 7500	-	14	6	1	21
7501 – 10000	-	8	5	3	16
>10000	-	4	-	1	5
Total	1	68	21	10	

As revealed in the Table, 68 per cent of the respondents under different age categories were observed to be in the SI range of 2.4 to 9.0 and 21 per cent were found to be in the higher range of SI 9.1 to 15.6 and 10 per cent of the respondents were observed to be in the highest range of 15.7 to 40.8.

As revealed in the Table, the age wise distribution revealed that more number of respondents in the age group below 50 were found distributed in the second category of SI (54 per cent), third category (17 per cent) and fourth category (7 per cent). Respondents above 50 were distributed as 14 per cent (second category), four per cent (third category) and three per cent (fourth category) in different categories.

Educational distribution of the respondents according to their smoking index revealed that education up to school level was observed among 43 per cent of the respondents in the second category, 16 per cent in third category and eight per cent in the fourth category. College level education was observed among 25 per cent of the respondents in the second category of SI, five per cent in the third category and two per cent in the fourth category of SI.

The occupational distribution of respondents in the different categories of SI revealed that in the second category 27 per cent were sedentary workers, 19 per cent were moderate workers and 22 per cent heavy workers. In the third category of SI, eight per cent sedentary workers, six per cent were moderate workers and seven per cent were heavy workers. Three per cent of the respondents in the fourth category of SI were sedentary workers while four per cent were moderate workers and three per cent were heavy workers.

Distribution of respondents on the basis of marital status revealed that out of the eleven per cent of unmarried respondents, six per cent were in the second category of SI while the remaining five per cent were in the third category. Among the 89 per cent of the married respondents, 62 per cent were distributed in the second category, 16 per cent in the third category and 10 per cent in the fourth category of SI.

Regarding the distribution of the respondents on the basis of income and SI revealed that 54 per cent of the respondents who were having a monthly income below Rs. 7500/- were distributed in the SI groups of third and fourth category. Respondents with an income of above Rs. 10,000/- were distributed as 12 per cent in second category, five per cent in third category and four per cent in the fourth category.

4.2.3 Distribution of respondents based on anthropometric status and SI developed

Major anthropometric measurements considered were height, weight, Mid-Upper Arm Circumference (MUAC) and Triceps Skin fold Thickness (TST). Table 8 furnishes the information relating to this data.

Twenty seven per cent of the respondents were found to have body weight below the standard weight stipulated. Twenty four per cent were possessing desirable weight and the remaining 49 per cent were found to be over weight.

Table 8 Distribution of the respondents based on anthropometric status and SI developed

N = 100

Particulars	SI				Total
	<2.3	2.4 – 9.0	9.1 – 15.6	15.7 – 40-8	
Weight (kg)					
50 – 60	-	14	7	6	27
60 – 70	-	17	5	2	24
70 – 80	1	22	8	2	33
> 80	-	15	1	-	16
Total	**1**	**68**	**21**	**10**	
Height (cm)					
150 – 160	1	9	4	5	19
160 – 170	-	32	9	4	45
170 – 175	-	13	2	-	15
> 175	-	14	6	1	21
Total	**1**	**68**	**21**	10	
MUAC (cm)					
<26.4	-	10	5	2	17
26.4-29.8	-	16	7	4	27
29.8-33.2	-	30	5	3	38
>33.2	1	12	4	1	18
Total	1	68	21	10	
TST (mm)					
<24	-	-	1	-	1
24.1-36.5	1	47	17	9	74
36.5-45.0	-	21	3	1	25
Total	**1**	**68**	**21**	10	

Nineteen per cent of the respondents were having a height between 150 to 160 cm where as 45 per cent were having a height between 160 to 170 cm. Fifteen per cent of the respondents were having a height in the range of 170 to 175 cm and 21 per cent were having a height more than 175cm.

Seventeen per cent of the respondents were having MUAC below or equal to 26.4, while 27 per cent were having the measurement in the range of 26.5 to 29.8. Thirty eight per cent of the respondents were having this value between 29.9 to 33.2 and 18 per cent were having MUAC as more than 33.3.

Seventy four per cent of the respondents were having a TST between 24.1 to 36.5 while 25 per cent were having a TST between 36.5 to 45.0 and the remaining one per cent was observed to have a TST less than 24.)

4.2.4 Distribution of the respondents based on their dietary profile and SI developed

Dietary profile of the respondents were monitored by ascertaining the frequency of use of food items rich in antioxidants and the details are presented in Table 9.

Daily consumption of different foods by the respondents in the second category of SI revealed that other vegetables were more frequently consumed (45 per cent) and it was followed by fruits (27 per cent), nuts and oil seeds (11 per cent), fleshy foods (11 per cent) and green leafy vegetables (10 per cent). Similar trend was observed regarding the consumption of other vegetables (12 per cent) and fruits (7 per cent) in the third category of SI.

Table 9 Distribution of the respondents based on their dietary profile and SI developed

N = 100

Particulars	<2.3	2.4 – 9.0	9.1 – 15.6	15.7 – 40.8	Total
GLV					
Occasionally	-	1	-	1	2
Weekly – 1	-	15	5	1	21
Weekly – 2	1	18	12	3	34
Weekly – 3	-	24	3	2	29
Daily	-	10	1	3	14
Total	**1**	**68**	**21**	**10**	
Roots and Tubers					
Weekly – 1	-	14	3	2	19
Weekly – 2	1	27	9	2	39
Weekly – 3	-	23	8	5	36
Daily	-	4	1	1	6
Total	**1**	**68**	**21**	**10**	
Other vegetables					
Weekly – 1	-	-	-	1	1
Weekly – 2	-	4	2	-	6
Weekly – 3	-	19	7	2	28
Daily	1	45	12	7	65
Total	**1**	**68**	**21**	**10**	
Fruits					
Occasionally	-	1	-	-	1
Weekly – 1	-	3	1	2	6
Weekly – 2	-	14	7	1	22
Weekly – 3	1	23	6	5	35
Daily	-	27	7	2	36
Total	**1**	**68**	**21**	**10**	
Nuts and oilseeds					
Occasionally	-	11	3	-	14
Weekly – 1	-	17	2	1	20
Weekly – 2	-	15	5	3	23
Weekly – 3	1	14	9	3	27
Daily	-	11	2	3	16
Total	**1**	**68**	**21**	**10**	
Flesh foods					
Occasionally	-	8	1	-	9
Weekly – 1	-	18	7	4	29
Weekly – 2	-	17	10	4	31
Weekly – 3	1	14	2	2	19
Daily	-	11	1	-	12
Total	**1**	**68**	**21**	**10**	

In the second category of SI, foods like green leafy vegetables (24 per cent), roots and tubers (23 per cent), fruits (23 per cent), other vegetables (19 per cent), nuts and oil seeds (14 per cent) and fleshy foods (14 per cent) were used weekly thrice, while in the third category none of these foods were used weekly thrice. But green leafy vegetables and fleshy foods were used weekly twice by 12 per cent and 10 per cent respectively by the respondents in the third category of SI.

Respondents in the second category of SI consumed foods like roots and tubers (27 per cent), green leafy vegetables (18 per cent), fleshy foods (17 per cent), nuts and oil seeds (15 per cent) and fruits (14 per cent) only weekly twice. The most popular foods, used by the respondents weekly once was fleshy foods (18 per cent) followed by nuts and oil seeds (7 per cent), green leafy vegetables (15 per cent) and roots and tubers (14 per cent). Eleven per cent of the respondents used nuts and oil seeds and eight per cent used fleshy foods occasionally.

4.2.5 Distribution of the respondents based on the anthropometric indices and SI developed

Table 10 shows the distribution of the respondents on the basis of selected health indices such as BMI and WHR against SI.

BMI was worked out and the respondents were classified into different groups based on BMI less than 17.0 (severe or moderate CED), 17.1 to 18.5 (mild CED), 18.6 to 20 (normal but under weight), 20.1 to 25 (normal) and more than 25 (obese).

Table 10 Association between SI and selected anthropometric indices

N = 100

Particulars	SI				Total
	<2.3	2.4 - 9.0	9.1 - 15.6	15.7 - 40.8	
BMI					
<17.0	-	1	1	1	3
17.1 – 18.5	-	1	-	1	2
18.6 – 20.0	-	9	4	2	15
20.1 – 25.0	1	38	15	5	59
>25.0	-	19	1	1	21
Total	**1**	**68**	**21**	**10**	
WHR					
<0.889	-	7	5	1	13
0.89-0.92	-	20	4	3	27
0.93 – 0.96	1	29	11	4	45
0.97 – 0.98	-	12	1	2	15
Total	**1**	**68**	**21**	**10**	

As revealed in the Table, three per cent of the respondents were having a BMI less than 17, indicating severe or moderate CED. Among the two per cent of the respondents having mild CED, one per cent was distributed in the second category and one per cent in the fourth category of SI group. Out of the 15 per cent of respondents who were normal but under weight, more respondents (9 per cent and 4 per cent) were distributed in lesser SI categories (second and third categories) and two per cent in the fourth category. Fifty nine per cent of the respondents were normal and were found distributed among different SI categories as one per cent (first category), 38 per cent (second category), 15 per cent (third category) and five per cent (fourth category). Twenty one per cent of the respondents were obese and were found to be distributed as 19 per cent (fourth category), one per cent (third category) and one per cent (fourth category).

With the information on waist and hip measurements, Waist-Hip Ratio (WHR), an indicator of general obesity was also developed, since a ratio above 0.9 was found undesirable. Among the 13 per cent of the respondents who had a WHR less than 0.889, seven per cent of the respondents were found distributed in the second category of SI, five per cent in the third category and one per cent in the fourth category. Twenty seven per cent of the respondents had a WHR between 0.89 – 0.92 and were distributed as 20 per cent (second category), four per cent (third category) and three per cent (fourth category).

Among the 45 per cent of the respondents who were under the WHR groups of 0.93 to 0.96, one per cent was under the first category of SI group, 29 per cent under the second category, 11 per cent under the third category and four per cent under the fourth category of SI group. Fifteen per cent of the respondents were having a WHR between 0.97 and 0.98. Among this 12 per cent belonged to the second category, one per cent in the third category and two per cent in the fourth category.

4.2.6 Influence of smoking habit on the BMI of respondents

Table 11 shows the distribution of respondents on the basis of their smoking habits against BMI.

Different variables taken into consideration under this context were the type of cigarettes used like unfiltered cigarettes, filtered cigarettes and beedis. Details of these used per day and the cigarette load indicating the product of number of cigarettes per day and the number of years of smoking is also furnished in Table 11.

As shown in the Table, 40 per cent of the respondents were in the habit of smoking less than 15 unfiltered cigarettes per day, 10 per cent were in the habit of smoking 16 to 23 unfiltered cigarettes a day and 10 per cent were in the habit of smoking 24 to 50 cigarettes a day.

Details related to the use of filtered cigarettes in a day indicated that 21 per cent of the respondents in this category smoked less than 15 cigarettes a day while 16 to 23 cigarettes were used by two per cent of the respondents and 24 to 50 by three per cent in a day.

Table 11 Influence of smoking habits on BMI of the respondents

N = 100

Variables	BMI					Total
	<17	17.1 – 18.5	18.6 – 20	20.1 – 25	>25	
Cigarette unfiltered						
<15	1	-	6	24	9	40
16 – 23	-	1	1	5	3	10
24 – 50	-	-	2	7	1	10
Total	**1**	**1**	**9**	**36**	**13**	
Cigarette filtered						
<15	-	1	3	10	7	21
16 – 23	1	-	-	1	-	2
24 – 50	-	-	-	2	1	3
Total	**1**	**1**	**3**	**13**	**8**	
Beedi						
<24	1	-	2	7	-	10
25 – 42	-	-	-	2	-	2
42 – 55	-	-	1	1	-	2
Total	**1**	**-**	**3**	**10**	**-**	
Cigarette load						
<389	1	1	10	38	16	66
390 – 728	1	-	4	15	4	24
729 - 2000	1	1	1	6	1	10
Total	**3**	**2**	**15**	**59**	**21**	

Ten per cent of the respondents were in the habit of smoking less than 24 beedis a day, while two per cent were smoking 25-42 beedis and the remaining two per cent used 42-55 beedis a day.

Data related to cigarette load revealed that 66 per cent of the respondents were having a cigarette load of less than 389, while 24 per cent had a cigarette load between 390 to 728 and 10 per cent had a cigarette load between 729 and 2000.

4.2.7 Influence of age of starting smoking on the health profile of respondents

Table 12 presents the details of the distribution of respondents on the influence of their age of starting of smoking on their health profile. The various parameters taken into consideration are BMI, SI and WHR.

As revealed in the Table, 10 per cent of the respondents started smoking at the age of 'less than 16', 48 per cent between '16 and 22 years', 27 per cent between '22 and 27 years' and 15 per cent started after the age of '27 years'.

Among the respondents surveyed, three per cent were with a BMI less than 17, for one per cent year of smoking was 'before 16 years', for one per cent it was between the ages of '16 to 22 years' and for one per cent it was between '22 to 27 years'. All the two per cent of the respondents having a BMI between 17.1 and 18.5 were found distributed in the age group of '22 and 27 years'.

Table 12 Influence of age of starting smoking on the health profile of respondents

N = 100

Particulars	Age of starting smoking				Total
	<16	16 – 22	22 – 27	>27	
BMI					
<17.0	1	1	1	-	3
17.1 – 18.5	-	-	2	-	2
18.6 – 20	3	4	5	3	15
20.1 – 25	4	34	11	10	59
>25	2	9	8	2	21
Total	**10**	**48**	**27**	**15**	
Smoking Index					
<2.3	-	-	-	1	1
2.4 – 9.0	7	28	22	11	68
9.1 – 15.6	2	14	3	2	21
15.7 – 40	1	6	2	1	10
Total	**10**	**48**	**27**	**15**	
WHR					
<0.889	2	6	3	2	13
0.890 – 0.92	3	12	12	2	29
0.93 – 0.958	2	22	10	9	43
> 0.959	3	8	2	2	15
Total	**10**	**48**	**27**	**15**	

Out of the 15 per cent of the respondents having a BMI of 18.6 to 20, three per cent were found identified in the age group of 'less than 16 years', four per cent under the group of '16 to 22 years', five per cent under '22 to 27 years' and three per cent under 'more than 27 years'. Among the 59 per cent of the respondents, four per cent were distributed in the age group of 'less than 16 years', 34 per cent under '16 to 22 years', 11 per cent under '22 to 27 years' and 10 per cent were belonging to the age group 'greater than 27 years'.

Out of the 21 per cent of the respondents with a BMI more than 25, two per cent were found distributed in the age group of 'less than 16 years', nine per cent between '16 to 22 years', eight per cent between '22 to 27' and two per cent 'more than 27 years'.

In the case of Smoking Index, out of 68 per cent of the respondents who were in the first category of SI, seven per cent were distributed under the age group of 'less than 16 years', 28 per cent under '16 to 22 years', 22 per cent under '22 to 27 years' and 11 per cent under the age group 'greater than 27 years'. Twenty one per cent of the respondents were in the SI group of third category. Of these two per cent were seen in the youngest group of 'less than 16 years', 14 per cent under '16 to 22 years', three per cent under '22 to 27 years' and two per cent were seen in the older group of 'above 27 years'. Out of the 10 per cent of the respondents in the SI group of fourth category, one per cent was found identified in the youngest group of 'less than 16', six per cent were found located in the younger group between '16 to 22 years', two per cent under '22 to 27 years' and one per cent under the older group of 'more than 27 years'.

Based on WHR, 13 per cent were having a WHR less than 0.889 of which two per cent were in the youngest group of 'less than 16 years', six per cent under '16 to 22 years', three per cent in the years of '22 to 27' and two per cent in the category 'above 27 years'.

Out of the 29 per cent of the respondents having a WHR between 0.89 to 0.92, three per cent were in the youngest group of 'less than 16 years', 12 per cent under '16 to 22 years', twelve per cent under '22 to 27 years' and two per cent under the category of 'more than 27 years'. Among the 43 per cent of respondents having a WHR of 0.93 to 0.958, two per cent were seen in the youngest group of 'less than 16 years', 22 per cent under '16 to 22 years', 10 per cent under '22 to 27 years' and nine per cent under the category of older group of 'more than 27 years'.

Fifteen per cent of the respondents were having a WHR greater than 0.959, among which three per cent were in the youngest group of 'less than 16 years', eight per cent in the group of '16 to 22 years', two per cent in the group of '22 to 27 years' and two per cent in the category of 'more than 27 years'.)

4.3 In-depth study on selected respondents

A sub sample of 20 respondents were selected from among the large sample based on the SI developed and consumption of antioxidants from food. The following aspects were included for in-depth study.

i. Actual food intake by weighment method

ii. Analysis of serum antioxidants and lipid profile

Table 13 Mean food intake of the respondents

N = 20

Food items	RDA (g)	Average quantity of food consumed	Percentage of RDA met
Cereals	460	344.85	74.96
Pulses	40	36.25	90.60
Roots and tubers	50	64.50	129.00
Other vegetables	60	37.50	62.50
Fruits	60	58.25	97.00
Green leafy vegetables	50	13.75	27.50
Milk and milk products	150	216.25	144.10
Flesh foods	60	45.75	76.25
Fats and oils	40	15.70	39.25
Sugar and jaggery	30	17.20	57.30

ICMR 1989

Table 14 Nutrient intake of the respondents (mean values)

N = 20

Nutrients	RDA	Average intake of nutrients	Percentage of RDA met
Calorie (kcal)	2425	1978.40	81.58
Protein (g)	60	48.13	80.21
Fat (mg)	20	51.54	257.70
Vitamin A (μg)	2400	1046.40	43.60
Vitamin C (mg)	40	58.44	146.10
Calcium (mg)	40	569.37	142.34
Iron (mg)	28	22.05	78.75

ICMR 1981

4.3.1 Actual food intake of the respondents

Mean food intake of the respondents studied is presented in Table 13 and Fig. 1.

The Table revealed that their diets were not balanced and insufficient to meet RDA in most of the cases except for roots and tubers (129 %) and milk (144 %). The increased consumption of milk was due to their habit of frequent drinking of tea. Most of the respondents were in the habit of drinking 5 – 6 cups of tea a day. The intake of fruits (mainly plantain) was observed to meet 97 per cent of RDA specification while pulses met around 90 per cent of RDA. The intake of other foods like flesh foods (76.25 %) and cereals (74.96 %) met about 3/4th of RDA specification where as other vegetables (62.5 %) and sugar and jaggery intake were just above 50 per cent of the RDA. The intake of foods such as green leafy vegetables (27.5 %) and fats and oils (39.25 %) were found to be insufficient meeting only less than 50 per cent of the RDA specification.

4.3.2 Nutrient intake of the respondents

Nutrients present in the diets of the respondents were calculated using food composition tables (Gopalan *et al.*, 1990) and the results are presented in Table 14 and Fig. 2. Except for fat (257.7 %), vitamin C (146.1 %) and calcium (142.34 %), all the other nutrients were observed as insufficient and did not meet RDA specifications.

Fig. 1 Actual food intake of the respondents

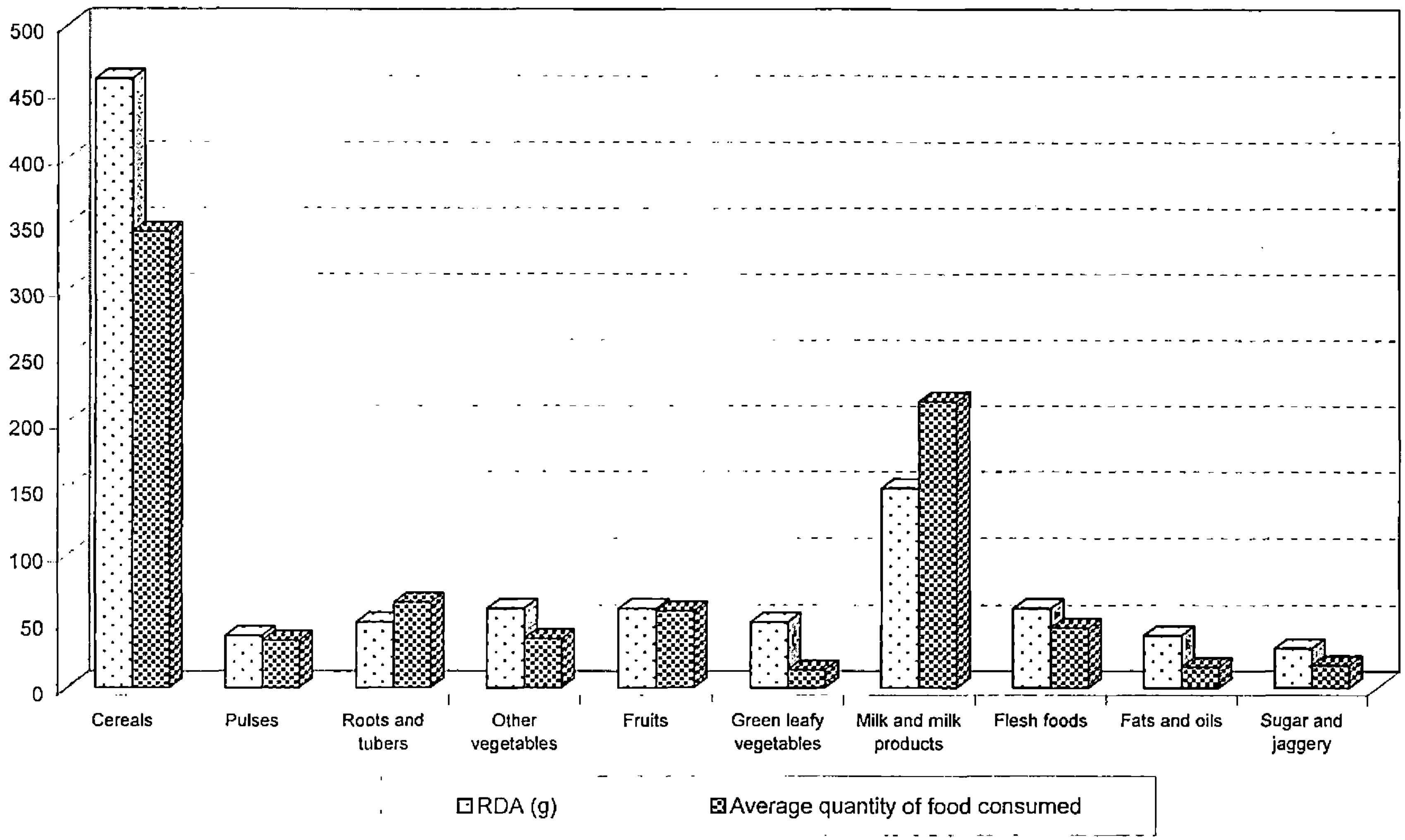
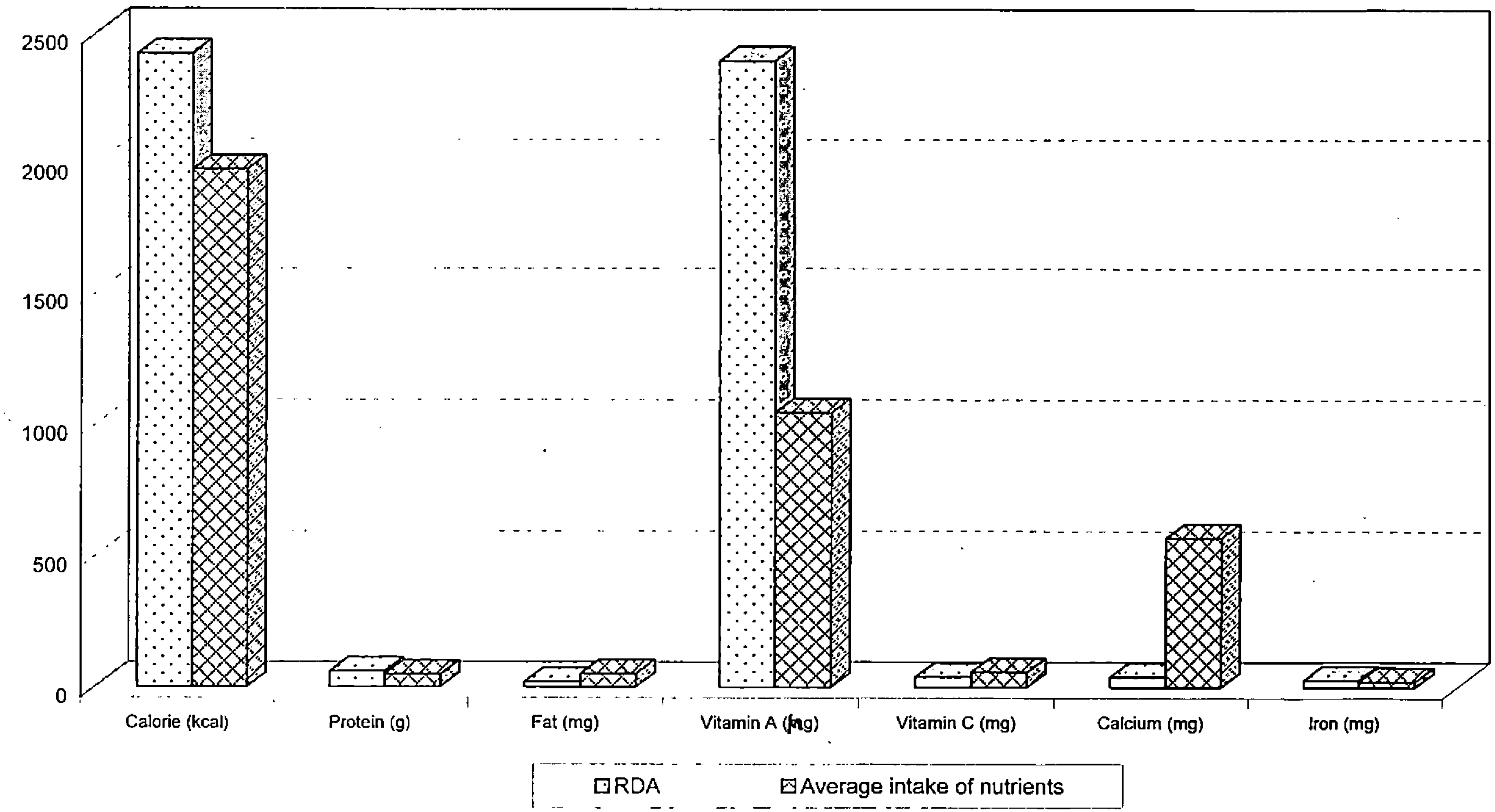


Fig. 2 Nutrient intake of the respondents



Mean calorie intake of the respondents were observed to be meeting 81.58 per cent whereas that of protein was found to be 80.21 per cent. The requirements for vitamin A (43.6 %) was found highly inadequate.

4.3.3 Serum profile of the respondents

Table 15 and Fig.3, 4 and 5 detail the serum profile of the respondents. As revealed in the Table, β-carotene in the serum was found to be in the range of 14 to 34 μg/dl. All the respondents were observed to be in the deficient state, when compared to the normal values. The mean serum β-carotene value of the respondents were found to be 19.9 μg/dl.

The serum vitamin E profile was found to be in the range of 4 to 9 μg/dl. All the respondents were observed to be deficient in serum vitamin E, when compared to the normal values. The mean serum vitamin E profile was found to be 6.3 μg/dl which was also found deficient when compared to the normal values.

The serum total cholesterol profile was found to be in the range of 136.0 to 186.0 mg/dl. All the respondents were having this value above the normal range. The mean serum total cholesterol was found to be 154.4 mg/dl.

The serum HDL-C profile was in the range of 46 to 88 mg/dl. All the respondents except one were having this profile above normal. The mean HDL-C profile was 68.1 mg/dl.

The serum LDL-C and triglycerides were in the range of 138 to 210 mg/dl and 186 to 280 mg/dl respectively. All the respondents were having both the values

Table 15 Serum profile of the respondents

Sl. No.	β-carotene (μg/dl)	Vitamin E (μg/dl)	Total cholesterol (mg/dl)	HDL – C (mg/dl)	LDL – C (mg/dl)	Trigly-cerides (mg/dl)	Haemo-globin (mg)	Albumin (mg)
1	23.0	7.0	168.0	47.0	160.0	240.0	14.2	5.1
2	16.0	6.0	186.0	48.0	170.0	260.0	14.0	5.6
3	14.0	5.0	140.0	46.0	108.0	280.0	13.8	5.3
4	20.0	8.0	136.0	67.0	196.0	270.0	14.6	4.3
5	34.0	6.0	140.0	54.0	180.0	235.0	14.0	4.3
6	30.0	7.0	160.0	86.0	190.0	218.0	14.3	5.2
7	24.0	6.0	158.0	58.0	170.0	280.0	14.2	5.1
8	20.0	5.0	180.0	64.0	160.0	210.0	14.5	5.5
9	14.0	5.0	146.0	68.0	180.0	225.0	12.7	4.1
10	18.0	4.0	166.0	77.0	138.0	220.0	14.6	4.8
11	20.0	8.0	148.0	78.0	188.0	214.0	13.9	4.6
12	22.0	7.0	166.0	78.0	180.0	216.0	14.1	5.3
13	21.0	9.0	156.04	86.0	170.0	200.0	14.4	4.8
14	20.0	6.0	148.0	70.0	190.0	194.0	13.9	5.2
15	20.0	6.0	138.0	69.0	210.0	210.0	13.7	5.1
16	17.0	6.0	148.0	74.0	178.0	186.0	14.6	5.7
17	16.0	7.0	140.0	70.0	196.0	220.0	13.4	4.4
18	15.0	5.0	160.0	68.0	180.0	210.0	12.8	4.0
19	14.0	6.0	156.0	74.0	168.0	195.0	13.5	5.3
20	20.0	7.0	148.0	78.0	176.0	210.0	14.9	5.4
Mean values	19.9	6.3	154.4	68.1	174.4	224.7	14.0	4.9

Fig. 3 Beta carotene content of serum

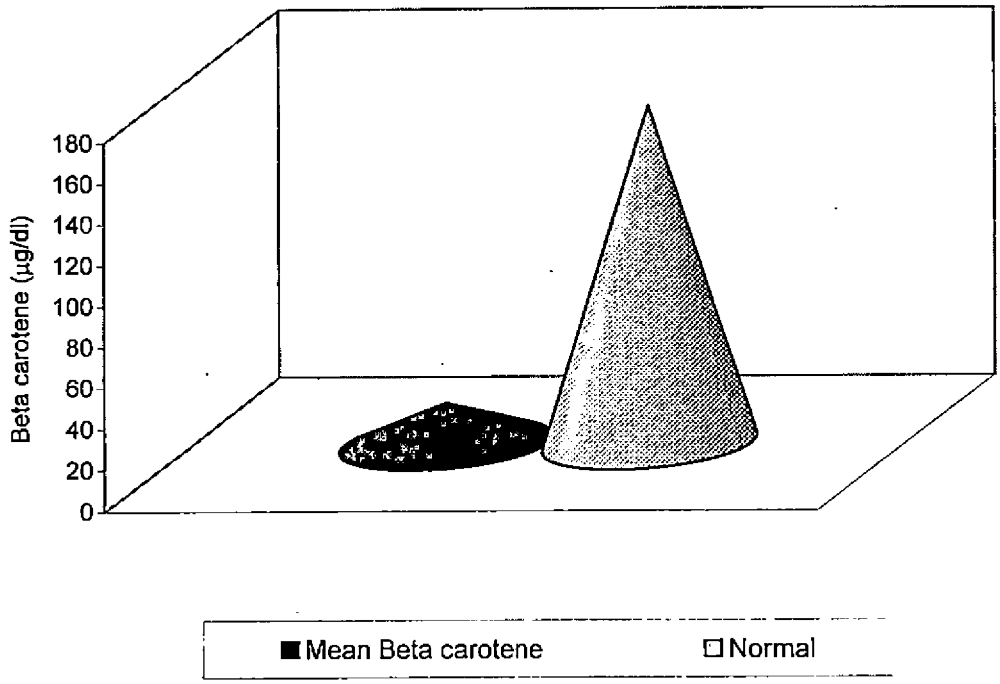


Fig. 4 Vitamin E content of serum

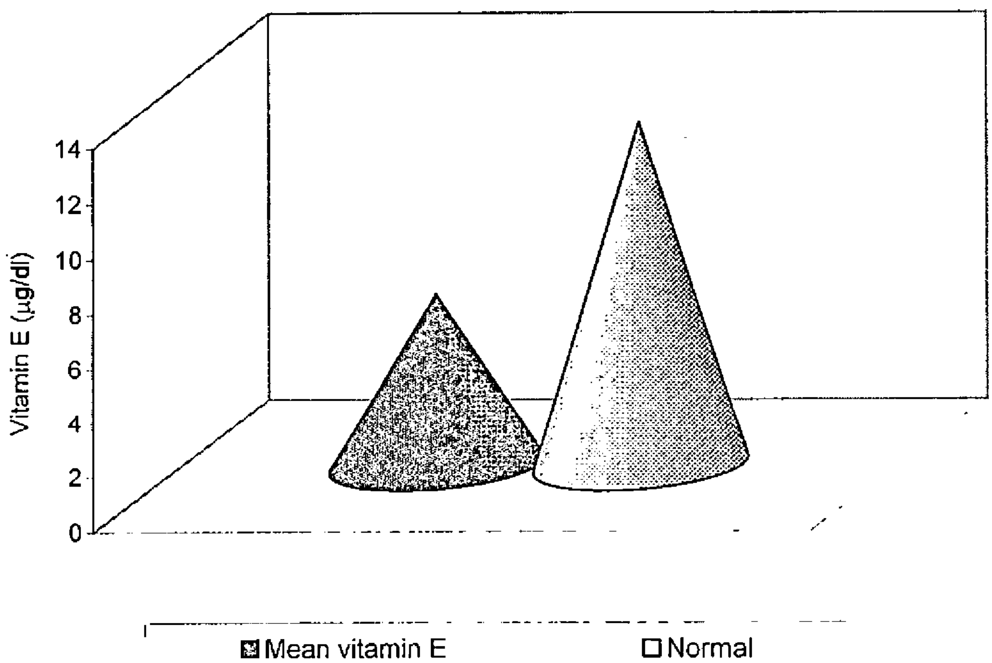
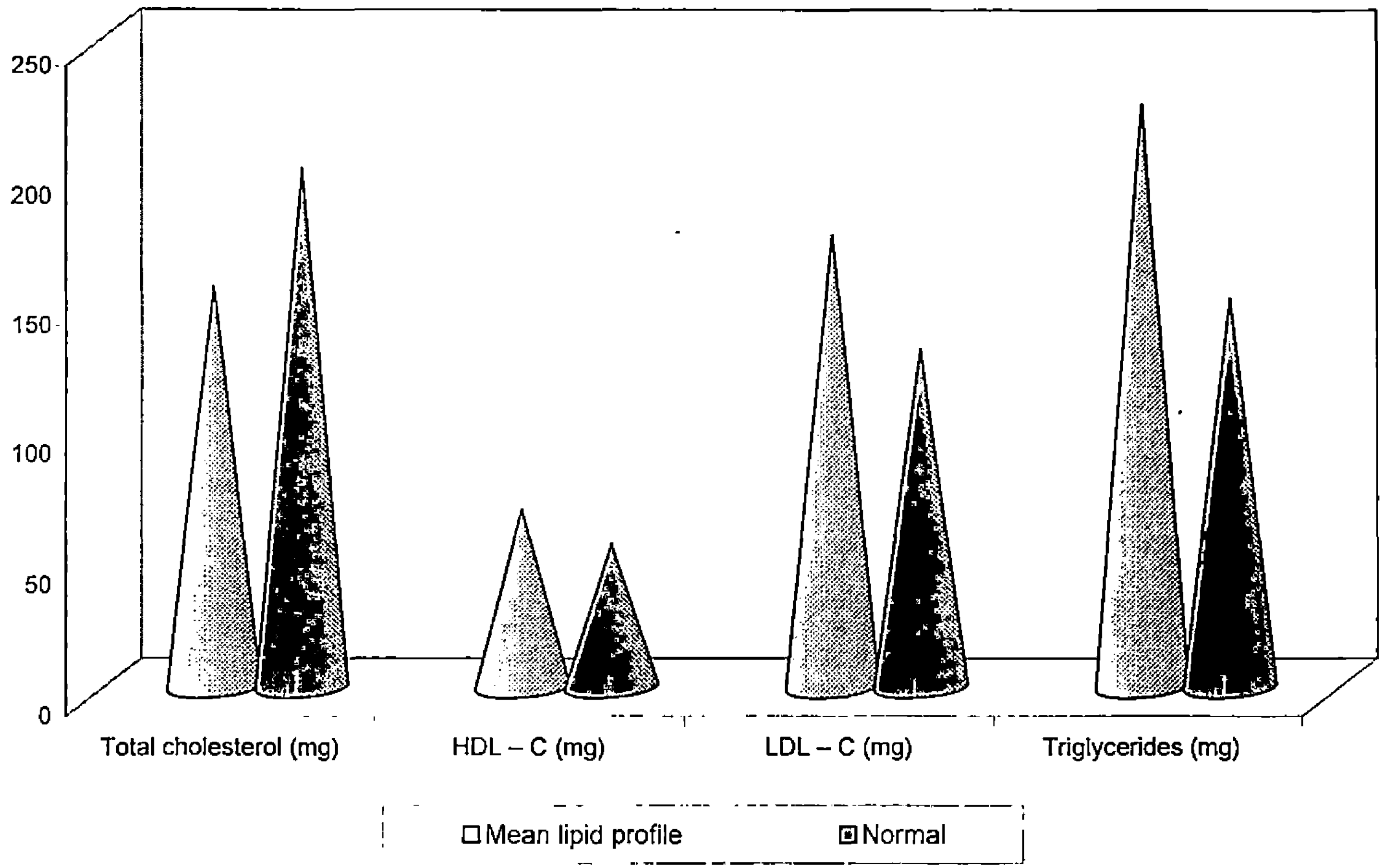


Fig. 5 Lipid profile of the respondents



above their respective prescribed normal values. The mean serum LDL-C was found to be 174.4 mg/dl and mean serum triglyceride level was 224.65 mg/dl.

The mean haemoglobin level ranged between 12.7 to 14.9 mg. All the respondents were having normal values and the mean value for serum haemoglobin was 14.0 mg. The serum albumin was also found to be in the normal level and it ranged between 4.0 to 5.6 mg. The mean serum albumin level was found to be 4.96 mg.

4.3.4 Influence of food use frequency on serum profile

Table 16 details the influence of consumption of antioxidant rich foods on serum profile of smokers. Antioxidants such as, β-carotene, vitamin E and vitamin C rich foods selected were green leafy vegetables, other vegetables and fruits are expressed as frequency of consumption in a week. Data pertaining to the frequency of consumption of green leafy vegetables indicated that there was no particular influence of this food group up on the serum levels of β-carotene; whereas a positive association (0.3284**) was observed between the consumption of drumstick leaves and vitamin E and negative association (-0.3123**) between the consumption of drumstick leaves and total cholesterol. However there was an indication of negative influence of green leafy vegetables on the serum levels of HDL-C (-0.5048**), LDL-C (-0.6125**) and triglycerides (-0.2582**).

**correlation at one per cent level

Table 16 Influence of antioxidant rich foods on serum profile of respondents

N = 20

requency of use of food items	No. of respondents	Serum profile					
		β-carotene (μg/dl)	Vitamin E (μg/dl)	Total cholesterol (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)	Triglyceride (mg/dl)
reen leafy egetables							
aily	4	19 (-146)	6.25 (-6.25)	160 (40)	62 (7)	184 (54)	237.5 (87.5)
eekly thrice	1	21 (-144)	9 (-3.5)	156 (44)	88 (33)	170 (40)	200 (50)
eekly twice	2	18 (-147)	6 (-6.5)	153 (47)	62 (7)	144 (14)	248 (98)
eekly once	9	21.5 (-143.5)	6.4 (-6.1)	153.1 (46.9)	65.8 (10.8)	176.4 (46.4)	221 (71)
ccasionally	4	16.5 (-148.5)	6 (-6.5)	160.5 (39.5)	71 (16)	171 (41)	210 (60)
oots and Tubers							
eekly thrice	3	19 (-144)	7 (-5.5)	158 (42)	74.6 (19.6)	182.6 (-52.6)	213.3 (63.3)
eekly twice	8	19 (-144)	6.25 (-6.25)	160 (40)	63.4 (8.4)	166.5 (-36.5)	234.3 (84.3)
eekly once	9	21.5 (-143.5)	6.3 (-6.2)	148.2 (51.8)	70.1 (15.1)	177.7 (47.7)	219.8 (69.8)
ther vegetables							
aily	1	16 (-149)	6 (-6.5)	186 (14)	48 (-7)	170 (40)	260 (110)
eekly thrice	8	18.9 (-146.1)	6 (-6.5)	156.3 (33.7)	78 (23)	176.5 (46.5)	176.5 (265)
eekly twice	9	20.3 (-144.7)	6.6 (-5.9)	147.1 (52.9)	69 (14)	172.8 (42.8)	236.6 (86.6)
eekly once	2	26.5 (-138.5)	7 (-5.5)	164 (46)	66.5 (11.5)	175 (45)	229 (79)
ruits							
aily	11	20.4 (-140.6)	6.3 (-6.2)	153.2 (46.8)	66.4 (11.4)	178.7 (48.7)	222.6 (72.6)
eekly thrice	3	21.6 (-143.4)	7.3 (-5.2)	157.3 (42.7)	82.6 (27.6)	176 (46)	204.3 (52.3)
eekly twice	3	20.7 (-145.3)	6.6 (-5.9)	154.6 (45.4)	68.6 (13.6)	182 (52)	238.6 (88.6)
eekly once	3	17.6 (-147.4)	5.3 (-7.2)	155.3 (44.7)	59.3 (4.3)	149.3 (-0.7)	238.3 (88.3)
ormal values		**40 – 250 μg/dl**	**5 – 20 μg/dl**	**150 – 250 mg/dl**	**>55 mg/dl**	**<130 mg/dl**	**>150 mg/dl**

Numbers given in parenthesis indicate deviation from normal values

In the case of roots and tubers no particular influence was found between their intake on the serum profile of β-carotene, vitamin E, HDL-C and LDL-C whereas it was observed that, with the increase in the frequency of consumption of the roots and tubers especially carrot, tapioca, onion and yam there was decrease in the serum profile of total cholesterol (-0.2444*) and triglycerides (-0.4918**).

Data regarding the consumption of other vegetables revealed no particular influence upon β-carotene and triglycerides. But the influence of other vegetables on the serum levels of vitamin E (0.1999*), total cholesterol (-0.3619**), HDL-C (-0.5235**) and LDL-C (-0.2766**) should be noted.

The frequency of consumption of fruits revealed a positive influence on β-carotene (0.4697**) and a negative influence on HDL-C (-0.2459*) and LDL-C (-0.2695**). In the case of vitamin E, total cholesterol and triglycerides,the influence of this food group was not found uniform.

Table 17 details the influence of consumption of fat rich foods on serum antioxidants and lipid profile of the smokers. The frequency of consumption of foods included were milk and milk products, fats and oils, nuts and oil seeds and fleshy foods.

Data pertaining to the consumption of milk and milk products as well as fats and oils indicated that daily consumption of these foods groups affects the serum lipid profile. A significant positive association was observed between milk consumption and total cholesterol (0.2561**) and also with triglycerides (0.3822**). A positive correlation was observed between the

*correlation at five per cent level ** correlation at one per cent level

Table 17 Influence of fat rich foods on the serum profile of the respondents

N = 20

Frequency of use of food items	No. of respondents	Serum profile					
		β-carotene (μg/dl)	Vitamin E (μg/dl)	Total cholesterol (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)	Triglyceride (mg/dl)
Milk and milk products							
Daily	20	20.15 (-144.9)	6.4 (-6.1)	154.4 (-45.6)	68.1 (13.1)	174.4 (44.4)	224.7 (74.7)
Fats and oils							
Daily	20	20.15 (-144.9)	6.4 (-6.1)	154.4 (-45.6)	68.1 (13.1)	174.4 (44.4)	224.7 (74.7)
Nuts and oils seeds							
Weekly thrice	6	18.5 (-146.5)	6.3 (-6.2)	146 (54)	69.2 (142)	172.6 (42.6)	215.8 (65.8)
Weekly twice	5	19.2 (-145.8)	6.8 (-5.7)	153.6 (46.4)	71.6 (16.6)	180.4 (50.4)	225 (75)
Weekly once	3	28 (-137)	6.3 (-6.2)	146 (54)	69.1 (14.3)	193.3 (63.3)	221 (71)
Occasionally	6	18.6 (-146.4)	5.8 (-6.7)	168 (42)	63.6 (8.6)	164 (34)	225 (75)
Flesh foods							
Daily	2	21 (-144)	6.5 (-6)	157 (43)	57.5 (2.5)	170 (40)	232.5 (82.5)
Weekly thrice	4	19 (-146)	5.8 (-6.7)	156 (44)	64.3 (9.3)	164.5 (34.5)	229 (79)
Weekly twice	6	19 (-146)	6.2 (-6.3)	152 (48)	71.4 (16.4)	174 (44)	224 (74)
Weekly once	6	21.6 (143.4)	7 (-5.5)	150.6 (49.4)	74.2 (19.3)	180 (50)	248.2 (98.2)
Occasionally	2	32 (-133)	6.5 (-6)	150 (50)	70 (15)	185 (55)	226.5 (176.5)
Normal values		**40 – 250 μg/dl**	**5 – 20 μg/dl**	**150 – 250 mg/dl**	**>55 mg/dl**	**<130 mg/dl**	**>150 mg/dl**

Numbers given in parenthesis indicate deviation from normal values consumption of fat and total cholesterol (0.2370*) as well as with triglycerides (0.2148*).

As in the case of nuts and oil seeds it was observed that the frequency of consumption of these food groups had an influence on LDL-C and triglycerides.

Frequency of consumption of flesh foods was found to have a definite positive influence on β-carotene (0.3152**), total cholesterol (0.3191**), and triglycerides (0.4663**). The influence of this food item, on other serum profile parameters such vitamin E, HDL-C and LDL-C were not uniform.

4.3.5 Association between the serum profile and SI developed

Table 18 details the association between the intensity of smoking (expressed as SI) and serum profile of the twenty respondents belonging to the sub sample. As revealed in the Table, none of the respondents were having a SI less than 2.3 (first category) where as maximum number of respondents (10 nos) belonged to the SI range of 2.4 to 9.0 (second category). Rest of the respondents belonged to the third (9.1 to 15.6) (6 nos) and fourth (15.7 to 40.8) (4 nos) categories of SI.

As shown in the Table, the mean serum β-carotene was 22.6 μg/dl among the second category of SI group whereas the serum β-carotene for the third and fourth categories of SI group were observed to be 16.16 μg/dl and 18.8 μg/dl respectively. The range of serum β-carotene among the three

Table 18 Association between serum profile and SI developed

Serum profile	2.4 – 9.0 (10 nos.)	9.1 – 15.6 (6 nos.)	15.7 – 40.8 (4 nos.)
β-carotene (μg/dl)			
Range	16 – 34 (22.6)	14 – 20 (16.2)	15 – 24 (18.8)
Vitamin E (μg/dl)			
Range	6 – 9 (6.8)	4 – 8 (5.6)	5 – 7 (5.8)
Total Cholesterol (mg/dl)			
Range	136 – 186 (154.6)	140 – 166 (150.6)	140 – 180 (158.5)
HDL-C (mg/dl)			
Range	47 – 88 (68.5)	46 – 78 (69.5)	58 – 70 (66)
LDL-C (mg/dl)			
Range	170 – 210 (182.2)	108 – 188 (160)	160 – 196 (176.5)
Triglycerides (mg/dl)			
Range	194 – 270 (225.3)	186 – 280 (220)	210 – 280 (230)
Haemoglobin (mg)			
Range	13.7 – 14.9 (14.2)	12.7 – 14.6 (13.9)	12.8 – 14.5 (13.7)
Albumin (mg)			
Range	4.3 – 5.6 (5.0)	4.1 – 5.7 (4.9)	4.0 – 5.5 (4.8)

Values in parenthesis gives the mean values different categories were 16 to 34 μg/dl (second category), 14 to 20 μg/dl (third category) and 15–24 μg/dl (fourth category).

The mean serum vitamin E profile for the second category was found to be 6.8 μg/dl, for third category 5.6 μg/dl and for the fourth category it was 5.8 μg/dl. The range of the vitamin E profile among the different SI categories like second (6 to 9 μg/dl), third (4 to 8 μg/dl) and fourth (5 to 7 μg/dl) categories also detailed in the Table.

Details pertaining to other lipid constituents like total cholesterol HDL-C, LDL-C and triglycerides are also presented in the Table.

The mean total cholesterol in the serum for the second category was estimated to be 154.6 mg/ dl and in the range of 136 to 186 mg/dl while that of the third category was 150.6 (range 140 to 166 mg/dl) and for fourth category it was 158.5 mg /dl (range 140 to 180 mg/dl).

As revealed in the Table, the mean serum profile of HDL-C was found to be 68.5 mg/dl for the second category where the level was found to be in the range of 47 to 88 mg/dl whereas the mean HDL-C for the third category was 69.5 mg /dl with a range of 46 to 78 mg/dl and in the fourth category the mean HDL-C was 66 mg/ dl with a range of 58 to 70 mg/dl.

In the case of LDL-C, the mean serum profile was 182.2 mg/dl for second category with a range of 170 to 210 mg/dl and with mean of 160 mg/dl for the third category having a range between 108 to 188 mg/dl. The mean

LDL-C was found to be 176.5 mg/dl and range of values were between 160 to 196 mg/dl for the fourth category of SI group.

The mean triglycerides profile was found to be 225.3 mg for the second category of SI group and the values ranged between 194 to 270 mg; for the third category it was found to be 220 mg and the range of values were found to be between 186 to 280 mg and for the fourth category, the mean serum triglycerides profile was observed to be 230 mg and the values were in the range 210 to 280 mg.

Along with serum antioxidant and lipid profiles, the haemoglobin and albumin content of the respondents were also analysed and the details are also presented in Table 20.

The mean haemoglobin and albumin profile for the second category were observed to be 14.2 mg and 5.03 mg respectively the range was observed to be 13.7 mg to 14.9 mg and 4.3 to 5.6 mg respectively. For the third category the values were found to be 13.9 mg (range 12.7 to 14.6 mg) and 4.9 mg (range 4.1 to 5.7 mg) respectively for haemoglobin and albumin and finally for the fourth category the serum profile for haemoglobin was found to be 13.7 mg (range 12.8 to 14.5 mg) and 4.8 mg (range 4.0 to 5.5 mg) for albumin.

Statistical analysis of the data revealed a strong positive association between vitamin E and SI developed, which was significant at one per cent level (0.3127**). Similarly a positive association at five per cent level was observed between total cholesterol and SI (0.1965*) and also between triglycerides and SI (0.2499*). No significant association was observed for SI with serum levels of β-carotene, HDL-C, LDL-C, haemoglobin and albumin.

Discussion

5. DISCUSSION

This chapter encompasses a critical appraisal of the salient findings of the study entitled 'Dietary antioxidants and lipid profile of smokers'.

5.1 Socio-economic profile of the respondents

Socio-economic factors have a definite bearing on the dietary habits of the people and thereby on their dietary intake and nutritional status. Australian and British research have shown that mortality rates for the diseases for which smokers are known to be at high risk are higher among individuals in lower socio-economic groups (Townsend, 1994). According to Juna (2000), smoking, physical inactivity, obesity, hypertension and poor diet are clustered in the lower socio-economic groups.

Smokers may increase the number of cigarettes they use and inhale more deeply when they switch on to lower yield cigarettes. Carbon monoxide which is a major component of cigarette smoke has been impugned as a harmful constituent.

Cancer incidence and mortality are found related to socio-economic status, especially, lung cancer is clearly more prevalent among lower socio-economic groups and less prevalent among higher socio-economic groups. Williams *et al.* (1991) have stated that the lowest socio-economic group experienced a mortality rate from lung cancer almost 50 per cent higher than that of the highest socio-economic group. Analysis of data generated in the Australian Institute of Health and Welfare, between 1985-1987 revealed that males of lowest occupational prestige experienced 260 per cent more lung cancer than those in the highest bracket. As well as reflecting smoking behaviour, higher disease rates among members of the lower socio-economic groups is also observed to reflect some degree of occupational exposure to carcinogens.

Smoking is one of the biggest hazards today. The results of the present study revealed that 61 per cent of the respondents surveyed were found to be in the habit of smoking 10-15 cigarettes per day, while 14 per cent were found to smoke more than 30 cigarettes per day. The larger a person smokes the greater is his risk of dying. Simone (1998) reported that a person who smokes two packs a day has a death rate two times higher than a non-smoker. The earlier a person starts smoking, the higher is his risk of death. In the present study 48 per cent of the respondents started smoking between the age of 16 and 22 years while 10 per cent of them started smoking at the age of less than 16 years and 15 per cent started after the age of 27 years. Similarly smokers who inhale have higher mortality rates than smokers who do not. It was observed in the present study that it was the younger respondents who smoked more number of cigarettes while there were only very few respondents who smoked more than 35 cigarettes a day after 55 years.

Educational status and literacy rate have been proved to be powerful determinants of nutritional status (Park, 1991) as it may influence the awareness about importance of good nutrition, which can affect food choice. So also those who are well educated will be placed in higher positions, drawing a good salary, which will increase the purchasing power of the family.

In the present study most of the respondents surveyed were having only school level education. Few respondents were having college level education and there were even a few who were illiterate. Education definitely plays a vital role in determining the socio-economic status of a family, since it assigns the occupational arena for the family members.

Park (1991) reported that Keralites are enjoying high standard of living inspite of low per capita income. The employment status of the population is an important determining factor with respect to health and nutritional status (Reddy *et al.*, 1999).

It was reported by Mc Michael (1985) that lung cancer death rates were lower among those in white collar occupations, indicating that these groups had lower smoking rates than blue collar groups for sometime. Doctors, dentists and lawyers and those of similar professional status had the lowest death rates at 19.9 per 100,000. Builders, labourers, miners, store men, domestic service workers and those of similar status had the highest death rates from lung cancer, around three times that of the lowest group at 54.7 per 100,000, which concludes that workers in the lower economic strata consumes more cigarettes than those in the higher ones.

The occupational distribution of the respondents in the current study was more or less uniform. Moderate and heavy workers smoked more number of cigarettes. It could be the lack of education that makes these groups of workers more vulnerable to smoking, while most of the sedentary workers sticked on to lesser number of cigarettes per day.

Data pertaining to economic status revealed that 79 per cent of the respondents were belonging to an income range below Rs. 7500, among which a majority of the respondents smoked lower brands of cigarettes. It was mostly the higher income groups who used more number of cigarettes (>30). It was observed that the proportion of income spent on smoking was more among those with lesser income and also it was they who tend to smoke more number of cigarettes when compared to the higher income groups.

In the present study, 89 per cent of the respondents were found to be married and settled in life while a comparatively younger age group were found unmarried. The family system in India is changing at a fast rate. In the present study 92 per cent of the respondents were belonging to nuclear families. Similar findings were also reported by Juna (2000).

Family composition of the respondents surveyed in the present study revealed that more number of respondents belonged to four member families (48 per cent), whereas there were a few, in which the number of members exceeded seven. The total number of family members of all the 100 families was accounted to be 457, giving an average of 4.57 members per family. Park (1991) reported that the average family size in India was 4.0.

5.2 Dietary profile of the respondents

Food is the major vehicle for improving the nutrition of population and hence assessment of food consumption and dietary habits of the people is very important. Sheeja (2000) reported that dietary intake is found to be markedly influenced by income level, type of family and family composition, which may have an influence on the dietary habits of the respondents.

Diet is a vital determinant of health and nutritional status of people. The dietary habits of individuals/families/communities vary according to socio-economic factors, regional customs and traditions (Thimmayyamma and Parvathy, 1996).

In the modern era, type of family comes to bear definite influence on food habits. A nuclear family with lots of freedom on spending habits and time to take care of health of limited members of family, spent a sizeable portion of their budget on food, which invariably results in consuming carbohydrate rich fatty foods.

Lower the socio-economic status of the families, higher was the intake of cereals and lower was the intake of foods of animal and vegetable origin. A study conducted by Rahaman *et al.* (1999) was also in tune with this finding.

In the present study data pertaining to the frequency of food groups rich in antioxidants revealed that milk and milk products as well as fats and oils were used daily by all the respondents. The most commonly used oil for cooking was palm oil and coconut oil, which has higher levels of saturated fatty acids than mono-unsaturated and polyunsaturated fatty acids. They may also play a role in increasing the serum lipid profile (Steinberg, 1989).

Regarding the consumption of foods rich in antioxidants such as, vitamin E, vitamin C and β carotene, it was observed that green leafy vegetables were used daily only by 14 per cent of the respondents. The mean food use frequency score of green leafy vegetables was found to be 66. Roots and tubers were included in the daily diets of six per cent of the respondents. The mean frequency score obtained was 66. Sixty three per cent of the respondents used other vegetables daily. This is mainly because these food groups form a major ingredient of most of the Kerala dishes. The mean score obtained was 91.

Fruits were also found to be a preferred item of smokers. Thirty five per cent of the respondents used fruits daily, 35 per cent weekly thrice, 23 per cent weekly twice, six per cent weekly once and one per cent occasionally (mean frequency score : 79). This is mainly because fruits like plantain and lime are easily available during all seasons in the market and their cost is comparatively lower than other seasonal fruits like mango and apple. Studies conducted by Lisa (1996) also indicated similar results. But, Zondervan *et al.* (1996) reported that female smokers showed a lower intake of fruits, vegetables and milk when compared with female non-smokers.

Foods like nuts and oil seeds as well as flesh foods (meat, egg etc.) were not very popular among the respondents and their mean frequency score obtained were 62 and 55. The reduced consumption of flesh foods could be due to their higher cost when compared to that of others. But, Gonzalez *et al.* (1997) reported that heavy smokers were more likely to have higher intake of eggs, whole milk, pork and other fried foods. Unhealthy eating patterns and smoking are also observed to be highly associated. According to Jerman (2000) heavy smokers showed a less healthy dietary profile than both light smokers and non-smokers.

5.3 Association between socio-economic profile of the respondents and SI developed

Smoking Index developed was a measure of the intensity of smoking of the respondents. An assessment of the relationship between the socio-economic variables such as age, education level, occupation and income revealed that the enhancement of age in the above three categories were found to have no direct influence on SI.

The respondents with higher SI were found to be equipped with moderate (high school level) and high (college level) education. However the educational level distribution of the respondents were found to have no proportionate effect on SI. Similarly, the type of physical activity undertaken by the respondents as well as the marital status of the respondents were found to have no direct effect on SI. Distribution of the respondents based on income level revealed that higher percentages, from the lower income group were found identified with higher SI.

Statistical treatment of the data revealed a positive significant association at 5 per cent level (0.1991*) between age and SI and Chi square analysis of the data revealed a significant association between SI and education (6.69**). No significant association for SI with occupation, marital status and income was observed.

5.4 Association between anthropometric profile of the respondents and SI developed

Nutritional anthropometry is a measurement of human body at various ages and levels of nutritional status. According to Beaton *et al.* (1990)

anthropometry is useful because it provides strong and feasible predictors, at individual levels of subsequent ill health, functional impairment and mortality. It is an accepted toll for the assessment of nutritional status.

Body weight is the most widely used and simplest reproducible anthropometric measurement for the evaluation of nutritional status. It indicates the body mass as a composite of body constituents. It was observed in the present study that majority of respondents were having body weight above normal level, very few were with normal weight and some of them were under weight. Stamford (1997) reported that smokers also tend to weigh less than those who have never smoked. The reason for this could be that smokers have a decreased sense of taste.

The height of an individual is influenced by genetic and environmental factors. The maximum growth potential of an individual is decided by hereditary factors, while the environmental factors, the most important being nutrition and morbidity, determine the extent of exploitation of that genetic potential. Inadequate dietary intake and / or infections reduce nutrient availability at cellular level resulting in growth retardation. In the present study fifty percent of the respondents were having a height above the normal level, 40 per cent were with normal height and 10 per cent with height below the recommended standards.

Fat fold at triceps is the most commonly measured fat fold. This measurements help to assess the amount of subcutaneous fat which inturn gives an indication of the calorie reserves in the body of an individual. In the present study majority of the respondents were having a normal TST.

Poor musculature and wasting are cardinal features of protein energy malnutrition in early childhood. Mid Upper Arm Circumference is recognized to indicate the status of muscle development. In the present study majority of the respondents were having a measurement above 30 cm and a few of them were having MUAC below 25 cm.

Statistical treatment of the data on anthropometric status and SI developed revealed a negative significant association at one per cent level between SI and MUAC (-0.2884**), between SI and TST (-0.2731**), while negative but significant association at five per cent level between SI and weight (-0.2049*) was observed.

The ratio of weight (in kg) / height^2 (m^2) is referred to as Body Mass Index (BMI). BMI has been shown to be a good indicator of nutritional status and functional status (Nutrition News, 1990). BMI was strongly and inversely associated with cigarette smoking and physical activity and positively associated with social class and alcohol intake. The incidence of CHD increased progressively with increasing BMI (Stamford, 1997). Current smokers had higher overall mortality rates than former smokers and never smokers at all BMIs.

The present study results revealed that majority of the respondents were in the normal range of BMI (20.1 to 25.0) and a few were obese. Systolic and diastolic BP, total cholesterol, glucose triglyceride, urate, packed cell volume and insulin levels were lowest in BMI under 20 and rose progressively to high levels in those with BMI over 30. An increase in one BMI unit from 20 – 22 onwards was associated with an approximately 10 per cent increase in the combined end points of death, coronary heart disease, stroke and diabetes. According to Royston and Lopez (1987) BMI is of value in distinguishing the nutritional state of different groups, monitoring the adequacy of food and in specifying the proportion of malnourished in a population.

Tuomilenhto *et al.* (1990) reported that WHR was independently related to several cardiovascular risk factors and an increased WHR indicated increased accumulation of abdominal fat. Most of the respondents in the current study were having WHR in the normal range with a very few in the above normal category and few in the below normal category.

Statistical analysis of the data on anthropometric indices and SI showed a negative but significant correlation between BMI (-0.2090)* and WHR (-0.2305)* with SI.

Statistical treatment of the data showed a negative but significant correlation between smoking of beedis and BMI (-0.2172)*. All the other variables such as use of unfiltered cigarettes, filtered cigarettes and cigarette load were found to have no relation with the BMI of the respondents.

Statistical analysis of the data revealed that no significant relation exists between age of starting smoking and the selected anthropometric indices such as BMI and WHR.

5.5 Association between dietary profile of the respondents and SI developed

The frequency in use of different foods by the respondents and the SI developed, were found to be not in uniform. The statistical analysis of the data revealed significant positive association for SI with nuts and oil seeds

(0.2412)*, while foods like green leafy vegetables, roots and tubers, other vegetables, fruits, milk and milk products, fats and oils and fleshy foods were found to have no association with SI.

5.6 Food intake of the selected respondents (20)

There is a general belief that the dietary habits of smokers may differ significantly from those of non-smokers. Past research has found a positive association between smoking and fat intake and alcohol, coffee and fried foods (Sulsky, 1990). In depth studies on the sub sample revealed that the intake of nutrients like calorie and protein were satisfactory, meeting around 80 per cent of RDA specifications. But in the case of fats it was much higher than the values stipulated by the RDA, which concludes that smokers eat more fat rich foods. It was also observed that their consumption of fats and oils as a food group was very poor meeting only 39.3 per cent of the recommended level and the remaining from 'invisible fats' in the foods. The higher intake of fat as a nutrient may be due to their higher consumption of animal foods like milk, egg, fish and meat. It was observed that most of the respondents consumed around five to six cups of tea a day. So their milk consumption contributes to a good proportion of protein intake and also that of fat and calcium. Lisa (1996) had also reported similar findings.

It was observed in the present study that nutrient intake of vitamin A (43.6 per cent) and iron (78.7 per cent) were insufficient, whereas vitamin C (146.1 per cent) and calcium (142.3 per cent) were above the RDA levels. The energy intake was around 20 per cent less than the stipulated RDA values. Zondervan *et al.* (1996) also observed similar results. In the present study, the diets of smokers were deficient in all the food groups except for roots and tubers (129 per cent) and milk (144 per cent). Among the roots and tubers, the most commonly used one was tapioca. Sheeja (2000) reported that consumption of tapioca was more frequent among Keralites. In many of the families it was even used as a staple food.

Cereal requirement was met around 74 per cent of RDA, pulses 90 pre cent, other vegetables 62.5 per cent, fruits 97 per cent, green leafy vegetables 27.5 per cent, flesh foods 76.3 per cent, fats and oils 39.3 per cent and sugar and jaggery 57.3 per cent. This shows that the diets of smokers are insufficient and unhealthy. Wang and Roe (1994) reported that adult smokers frequently eat foods that contain too little vitamin C, vitamin E, too many calories and too much fat including saturated fat, cholesterol and sodium.

According to Scott (1996) smokers ate more snacks, for which they usually ate chocolate/crisps rather than fruits. Non-smokers ate more granary and whole meal bread than smokers, but smokers ate more chips and fried foods. They were also observed to consume slightly more alcohol, more tea (in males), more coffee (in females) and used more salt, pepper and sugar than non-smokers. Jerman (2000) had also reported similar results.

5.7 Antioxidant profile of the respondents

Antioxidants such as vitamin E, vitamin C and β-carotene are considered to be as protective nutrients since they protect the bio-membranes from the harmful effects of lipid peroxidation.

Cigarette smoking reduces antioxidants in blood and tissue levels substantially leaving smokers more vulnerable to the harmful action of free radicals. Indeed, one single puff of a cigarette contains one hundred trillion free radicals, most of which are inhaled into the lungs and find their way into the blood stream. Yet, our bodies are not without effective means of protection against these free radicals. Antioxidants constantly fight and neutralize free radicals which are both generated in our organs during the normal wear and tear of body functions and are also inflicted upon us in the form of food, sun beams, automobile exhaust fumes and other environmental pollutants and last but not least cigarette smoke (Papas, 1999).

Recent evidence suggests that recommended allowances for protective nutrients should be raised for smokers. Thus smokers, who have an increased risk of developing many degenerative diseases due to smoking itself, also have lower body levels of nutrients that are protective against disease.

β-carotene

β-carotene is a very powerful antioxidant which helps to control several of the diseases like cancer, heart attack and cataracts. Women who ate foods containing 15.26 mg daily of β-carotene had lower risks of heart attacks and strokes than those who consumed less than 6 mg daily (Willet *et al.*, 1983). β-carotene was also found to be helpful for smokers. The normal levels of β-carotene was found to be 40 to 250 µg / dl. In the present study all the respondents were in a deficient state in the case of β-carotene. The mean serum β-carotene was found to be 19.9 µg / dl, which was far less than even the normal level. A positive association at one per cent level was observed between the consumption of fruits and serum levels of β-carotene (0.4697**), since many of the fruits are rich in carotenoids. Smoking enhances lipid peroxidation, which damages the cell components. It was observed in the present study that those who were having higher levels of serum β-carotene, their levels of lipid constituents were comparatively lower when compared with other respondents. It was reported by Jialal *et al.* (1991) that β-carotene prevents oxidation of LDL-cholesterol. The findings of the studies of Princen *et al.* (1992) and Pamuk *et al.* (1994) were also found to be on the same line.

Vitamin E

Vitamin E is the body's most effective antioxidant. Jessup (1990) reported that vitamin E is important in preventing oxidation of LDL cholesterol. Smokers have been found to have lower levels of plasma vitamin E than non-smokers (Stampfer, 1993). Tobacco smokers and chewers are encouraged to eat around nine servings of foods rich in vitamin E daily.

The normal serum levels of vitamin E was observed to be five to 20 μg / dl. Even though in the present study the serum levels of vitamin E was just above the lower limit, there never was a positive balance. The observed mean serum vitamin E was 6.3 μg / dl.

Evidence exists that vitamin E can help preventing atherosclerosis by interfering with the oxidation of LDL, a factor associated with increased risk of heart diseases (Stampfer, 1993). Rimm (1993) found that people who took vitamin E supplements had fewer deaths from heart disease. In the present study it was observed that consumption of green leafy vegetables (0.3284**) and other vegetables (0.1999*) have a positive influence on serum vitamin E profile.

In the present study the levels of serum vitamin E was also in a deficient state. This finding is in line with the results of Faruque *et al.* (1995).

5.8 Lipid profile of selected respondents

In fasting serum, triglycerides serve as a crude measure of the very low density lipoproteins, that deliver fats to tissues for storage or metabolism. An elevated level of lipoproteins or triglycerides indicate increased level of lipid peroxidation. Cigarette smoke is counted as one of the major factors which enhances this process. In the present study increased levels of triglyceride and cholesterol were observed. The normal range of total cholesterol was found to be 150 to 250 mg / dl, while the minimum and maximum serum cholesterol was observed in the present study were 136 and 186 mg / dl. The mean serum cholesterol was 154 mg / dl which was slightly higher than the minimum normal level. It could be the higher rate of lipid peroxidation induced by smoking that had increased the serum cholesterol of the respondents. Studies conducted by Gilligan *et al.* (1994) and Munoz *et al.* (1994) were also in line with the present result. Consumption of roots and tubers were found to reduce the serum cholesterol level. In the present study a negative correlation for serum cholesterol was observed with roots and tubers (-0.2444*) and with other vegetables (-0.3619**). A positive correlation for total cholesterol was observed with milk consumption (0.2561**), flesh foods (0.3191**) and fat consumption (0.2370**). Rao *et al.* (1993) was of the opinion that consumption of fat appears to influence the elevation of cholesterol in blood.

According to Arti and Rajeswari (1986), chain smoking had a deleterious effect on cholesterol and BP. Cerna *et al.* (1992) reported that increased lipid profile in both genders represent a cardiovascular risk factor and also correlate with increased blood clotting tendencies. This finding was supported by the results of studies conducted by Jha *et al.* (1995). Increased levels of HDL-C and LDL-C were also observed in the present study. Above normal levels of all the lipid constituents in the serum are dangerous except HDL-C, which is considered to be as 'good cholesterol', since it helps in the mobilization of peripheral cholesterol to the liver, which is the site of lipid metabolism.The normal value of serum triglycerides was less than 150 mg / dl, while the mean value was found to be 224.7 mg / dl. Consumption of green leafy vegetables (-0.2582**) and roots and tubers (-0.4918**) were found to reduce serum triglycerides levels while consumption of milk (0.3822**), fat (0.2148*) and flesh foods (0.4663**) were found to increase the serum level of triglycerides.

In the current study all the respondents were having higher levels of serum lipid constituents. This factor pre-disposes various diseases like atherosclerosis, hypertension and stroke in smokers. This finding is on par with the studies of Gaziano and Hennekens (1992). Lisa (1996) reported a significant positive correlation between the number of cigarettes smoked and the triglyceride, HDL-C and VLDL fractions of blood. Hence, antioxidant vitamins presumably exert their effect through protection of oxidation.

However, some studies have shown that the vitamins may also preserve endothelial function (Keany *et al.*, 1993), alter homeostasis and lower both LDL-C levels and blood pressure (Trout, 1991; Jacques, 1992; Stamler, 1993).

Results of the present study revealed some of the deleterious effect of smoking, which can help to make the public aware that smoking is nothing but a 'slow suicide'.

Based on the results evolved, the following conclusions were arrived.

- Majority of the respondents were in the habit of smoking 10 to 15 cigarettes per day and were smoking approximately for 10 to 20 years
- Lower the educational status, higher was the respondent's intensity of smoking
- More number of cigarettes were smoked by sedentary and heavy workers than moderate workers
- Protective foods rich in antioxidants were insufficiently used by the smokers
- Diets of the smokers were inadequate in quantity as well as in quality
- Nutrient intake of the respondents were deficient for calorie, protein, iron and vitamin A
- Smokers have reduced levels of serum antioxidants and elevated levels of serum lipid constituents

Recommendations

- Smoking is injurious to health, leading to various degenerative diseases, so quit smoking
- Foods rich in antioxidants like β-carotene, vitamin E and vitamin C needs to be included in abundance in the diets of smokers.

Summary

6. SUMMARY

The study entitled 'Dietary antioxidants and lipid profile of smokers' comprises information on the influence of various socio-economic, dietary and smoking habits on the health profile of selected respondents.

The study was conducted among 100 adult males, who used more than 10 cigarettes a day and were smoking for at least the past 10 years.

The health profile of the respondents were evaluated through, socio-economic profile, frequency of use of antioxidant rich foods, anthropometric status, actual food intake and biochemical estimation of serum profile of antioxidants and lipids.

It was observed that more than 50 per cent of the respondents were in the habit of smoking 10 to15 cigarettes a day, while only 14 per cent were found to smoke more than 30 cigarettes per day. Distribution of respondents on the basis of years of smoking was more or less the same in two ranges, viz., 10 to 15 years and 16 to 20 years. Only 12 per cent were smoking for more than 30 years.

More number of respondents (32 per cent) were distributed in the age group of 36 to 40 years. Most of the respondents were having an educational status up to high school level. The distribution of respondents on the basis of their physical activity was more or less the same.

Majority of respondents were married and residing in nuclear families. More number of the individual were distributed in the income group of

Rs. 2501-5000 and least in the group of more than10,000. Most of the respondents' families were comprised of four members.

On the basis of food use frequency score worked out, the most frequently used foods were milk and fats and oils, since they were used daily and the least popular among foods were flesh foods. Foods like other vegetables and fruits were included moderately in their daily diets.

The influence of the SI on the socio-economic profile of the respondents was found to be positive since more number of respondents were distributed on higher levels of SI. A similar trend was also applicable to anthropometry.

It was observed that SI has no particular influence on the dietary pattern of the respondents.

Analysis of the association between SI and selected anthropometric indices revealed that there exists a positive correlation at five per cent level between BMI and WHR with SI.

Influence of smoking habits on the BMI of the respondents was studied and was found that smoking beedis are more hazardous to health when compared to unfiltered or filtered cigarettes. Practically no significant relation exists between the age of starting smoking and the selected anthropometric indices.

Indepth study was conducted in 20 sub samples, by assessing their actual food intake by weighment method and their serum analysis for antioxidants and lipid profile.

Analysis of data pertaining to actual food intake revealed that the diets of respondents were inadequate and insufficient except for roots and tubers and milk. Frequent drinking of tea was also found to be a habit among smokers. The food groups that were least consumed by the respondents were green leafy vegetables and fats and oils. Nutrient intake of the respondents were also not uniform with the RDA specifications, especially calorie, protein iron and vitamin A.

The serum analysis of the respondents revealed that smokers have reduced levels of serum antioxidants and elevated levels of serum lipid profile, when compared with normal standards.

The influence of both antioxidant rich foods and fat rich foods on the serum profile of smokers were analysed. Most of the antioxidant rich foods except fruits did not have an influence on the serum antioxidant profile. But at the same time they were found to have an influence on the serum lipid constituents since, as their frequency of consumption increased, there was a decline in the serum lipid profile.

Frequent consumption of fat rich foods were found to increase the serum lipid profile, while not much affecting the serum antioxidant constituents.

Data pertaining to the association between the serum profile and SI of the respondents revealed a significant positive association between SI and serum levels of total cholesterol and triglycerides whereas the influence of SI on other constituents were not very significant.

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* Original not seen

Appendices

APPENDIX -I

KERALA AGRICULTURAL UNIVERSITY

Department of Home Science
College of Agriculture, Vellayani

SCHEDULE FOR THE SELECTION OF RESPONDENTS

1. Name
2. Age
3. Address

Section A

4. How long have you been smoking ?
5. How much cigarettes do you smoke a day ?

Section B

6. Do you have any particular disease

Diabetes
Hypertension
Kidney disease
Heart disease
Liver disease
Any other (specify)

7. Are you in the habit of taking multivitamin tablets ?
8. Do you consume alcohol regularly ?

APPENDIX -II

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

SCHEDULE FOR ASSESSING SOCIO ECONOMIC PROFILE OF SMOKERS

1. Name
2. Address
3. Age
4. Educational status
5. Occupation
6. Total monthly income (actual)
7. Type of family
8. Number of members in the family
9. Marital status

APPENDIX -III

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

SCHEDULE USED FOR COLLECTING DATA PERTAINING TO THE FREQUENCY OF USE OF FOODS RICH IN ANTIOXIDANTS

Food item	Daily	Weekly once	Weekly twice	Weekly thrice	Occasionally	Never
(a) Green leafy Vegetables Agathi Amaranth Cabbage Chekkurmanis Colocasia leaves Drumstick leaves Any other (specify)						
(b) Roots and Tubers Carrot Elephant yam Beet root						
(c)Other vegetables Bittergourd Drumstick Cauliflower Peas Mango (green) Pumpkin Snakegourd Tomato (green) Field beans French beans						
(d) Fruits Amla Banana (ripe) Cashew apple Guava Lime Mussambi Mango (ripe) Orange Papaya Pineapple						

Tomato (ripe)						
(e) Nuts and oilseeds Ground nut Gingelly seeds Badam						
(f) Flesh foods Beef muscle Egg (hen) Egg (duck) Mutton Liver						
(g) Milk and milk products Milk (cow's) Buffalo milk Toned milk (Milma) Curds Butter Ghee Cheese Paneer Milk powder						
(h) Fats and edible oils Fish liver oil Red palm oil Vegetable oils Gingelly oil Groundnut oil Sunflower oil Vanaspathi						

APPENDIX -IV

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

FORMULAE FOR MAKING FOOD USE FREQUENCY TABLE

$$\text{Score} = \frac{R_1 S_1 + R_2 S_2 + \ldots\ldots\ldots\ldots R_n S_n}{N}$$

S_n = Scale of rating

R_n = Percentage of respondents selecting a rating

N = Maximum scale rating

APPENDIX -V

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

SCHEDULE TO ELICIT INFORMATION ON THE ANTHROPOMETRIC STATUS OF THE RESPONDENTS

1. Name of the respondent :

2. Body weight (kg) :

3. Height (cm) :

4. Mid Upper Arm Circumference (MUAC) (cm) :

5. Triceps Skin fold Thickness (TST) (mm) :

6. Waist measurement (cm) :

7. Hip measurement (cm) :

8. Body Mass Index (BMI) :

9. Waist Hip Ratio (WHR) :

APPENDIX -VI

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

. SCHEDULE TO ELICIT INFOMRATION REGARDING THE SMOKING HABIT OF THE RESPONDENTS

1. Name of the Respondent

2. Age

3. What do you smoke ?

   Cigarette ☐ Beedi ☐

4. If cigarette,

   Filtered ☐ Unfiltered ☐

5. For how long have you been smoking (actual) ?

6. Number of cigarettes smoked per day (actual) :

APPENDIX -VII

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

INVENTORY ON FREQUENCY OF SMOKING

Name of the respondent :
Date :

Split up sign for one hour duration

Distribution of time (Hours)	First day	Second day	....	Seventh day
<6.00 A.M.				
6.00 to 7.00 A.M.				
7.00 to 8.00 A.M.				
8.00 to 9.00 A.M.				
.				
.				
.				
.				
6.00 to 7.00 P.M.				
7.00 to 8.00 P.M.				
8.00 to 9.00 P.M.				
>9.00 P.M.				
Total				

Instructions :

The respondents are to record the number of cigarettes used every one hour interval in a day

Details are to be recorded on subsequent seven days

APPENDIX -VIII

KERALA AGRICULTURAL UNIVERSITY
Department of Home Science
College of Agriculture, Vellayani

SCHEDULE USED FOR ASCERTAINING THE ACTUAL FOOD INTAKE OF THE RESPONDENTS (WEIGHMENT METHOD)

1. Name of the respondents

Name of the meal	Menu	Weight of each ingredient used by the family (g)	Weight of the total cooked food (g)	Amount of cooked food consumed by the respondent (g)

DIETARY ANTIOXIDANTS AND LIPID PROFILE OF SMOKERS

BY

PREETHI. N.R

ABSTRACT OF THE THESIS

Submitted in partial fulfilment of the requirement
for the degree of

MASTER OF SCIENCE IN HOME SCIENCE

(Food Science and Nutrition)

Faculty of Agriculture
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF HOME SCIENCE
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VELLAYANI
THIRUVANANTHAPURAM

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ABSTRACT

The study entitled 'Dietary antioxidants and lipid profile of smokers' comprises information on the influence of various socio-economic and dietary profiles, as well as smoking habits on the health profile of selected respondents.

The study was conducted among 100 adult males, who used more than 10 cigarettes a day and were in the habit of smoking for at least the past 10 years.

Analysis of the smoking habit of respondents revealed that more than 50 per cent of the respondents were in the habit of smoking 10 to15 cigarettes a day, while 14 per cent smoked more than 30 cigarettes a day. More number of them had been smoking for the past 10 to 15 years.

The socio-economic profile of the smokers indicated that most of the respondents were in the age group of 36 to 40 years.

Majority of the respondents were having an educational status of high school level. The occupational distribution of the respondents were more or less the same. Most of the respondents were married and were residing in nuclear families with four members. Majority of the respondents surveyed were having a monthly income between Rs. 2501 to 5000

On assessing the frequency of use of antioxidant rich food items, most of them used foods like milk and fats and oils most frequently while the least popular foods were flesh foods.

Assessment of the influence of Smoking Index (SI) developed upon the various variables revealed that socio-economic profile and anthropometry has a strong influence on SI. Influence of SI on the anthropometry revealed significant negative correlation with MUAC, TST and weight, whereas no particular influence of a SI observed on the dietary pattern.

Analysis of data pertaining to actual food intake revealed that the diets of respondents were inadequate and insufficient except for roots and tubers and milk. Nutrient intake of the respondents also did not meet the RDA specifications especially calorie, protein, iron and vitamin A.

The serum analysis of the respondents revealed that smokers have reduced levels of serum antioxidants and elevated levels of serum lipid profile, when compared with normal standards.

Assessment of the influence of different food groups upon the serum anti oxidant and lipid profile revealed that consumption of antioxidant rich foods not only helps to improve the serum antioxidant profile but also helps to control the serum lipid profile. Frequent consumption of fat rich foods were found to increase the serum lipid profile. Frequent consumption of fat rich foods were found to increase the serum lipid profile while not influencing the serum antioxidant constituents.

Data regarding the association between the serum profile and SI of the respondents revealed a significant positive association with total cholesterol and triglycerides.