Full Length Research Paper

The beneficial effects of garlic oil and garlic cake on coconut oil fed rats

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The feeding of coconut oil (CNO) at a level of 20% in terms of energy to normal rats for a month increased significantly blood sugar and lipids and protein content and lipid peroxidation in tissues (viz. Heart, liver and kidney) and enhanced the activities of aspartate and alanine aminotransferases and alkaline phosphatase in serum. Oral administration of garlic oil (100 mg/kg body wt) or cake (5% by weight in the diet) to CNO fed groups as above ameliorated the deranged parameters significantly. The results suggest that garlic oil and cake contain certain active principles that counteract the deleterious effects of CNO. Garlic oil is a better therapeutic agent than its oil free cake. This may be due to the high quantity of biologically active organosulphur compounds present in the former than that in the latter. However the cake can be used by those who do not like the odor of the oil.

Key words: Garlic oil, garlic cake, coconut oil, blood sugar, cholesterol, TAG, enzymes.

INTRODUCTION

Garlic (*Allium sativum Linn*) the spices of life is unique among the members of plant kingdom. It is used as a food additive and folk remedy for a variety of ailments in various parts of the world. During the past few years there has been a renewed interest in its medicinal uses. Garlic has been proposed to have a healing power in the treatment of hypertension (Rashid and Khan, 1985), heavy metal poisoning (Cha, 1987) athletes foot (Bolten et al., 1982) etc; in addition to its uses in various diseases due to its antiviral (Weber et al., 1992), antitumor (Hart-well, 1960), hypolipidemic (Lin, 1989; Adoga and Osuji, 1986), hypocholesterolemic (Nagai and Osawa, 1974), antiatherosclerotic (Sogani and Katoch, 1981), antioxidant (Augusti and Sheela, 1996) and immunomodulator (Kandil et al., 1987) effects. The present study is aimed for an investigation on the beneficial effects of two fractions of garlic. 1) Garlic oil which is rich in organic sulfides including diallyl sulphide, diallyl disulfide, diallyl trisulfide, diallyl tetra sulfide and poly sulfides and 2) Oil free garlic cake which contains active principles mainly sulfur rich amino acids, such as S-allylcysteine (SAC) their peptides such as -glutamyl S-alkyl cysteines (Whitaker, 1976) and proteins (Biju, 1996) on the deleterious effects of coconut oil consumption. Coconut oil is mostly saturated oil, attributed with hypercholesterolemic effects (Vanheck and Zilversmit, 1991), if used in excess. Apart from the organic sulfides some ether soluble fat (around 15%) is also present in garlic oil and it was not removed from our sample due to lack of techniques in our laboratory Coco-nut oil contains mostly saturated fatty acids, but short chain fatty acids with very little unsaturated fatty acids (Rajmohan and Augusti, 1996), viz; oleic and linoleic acids are also present in this oil. The major saturated fat-ty acids are lauric (49%), myristic (17%), palmitic (9%), and capric (7%) acids.

In the present study we aimed to screen whether CNO feeding at 20% level of the energy requirements of rats could raise the lipid profile and if so whether a simultaneous feeding of garlic oil or cake to these animals could counter the bad effects of CNO. For these tests we used essential oil of sun dried garlic powder and locally purchased coconut oil for a period of one month.

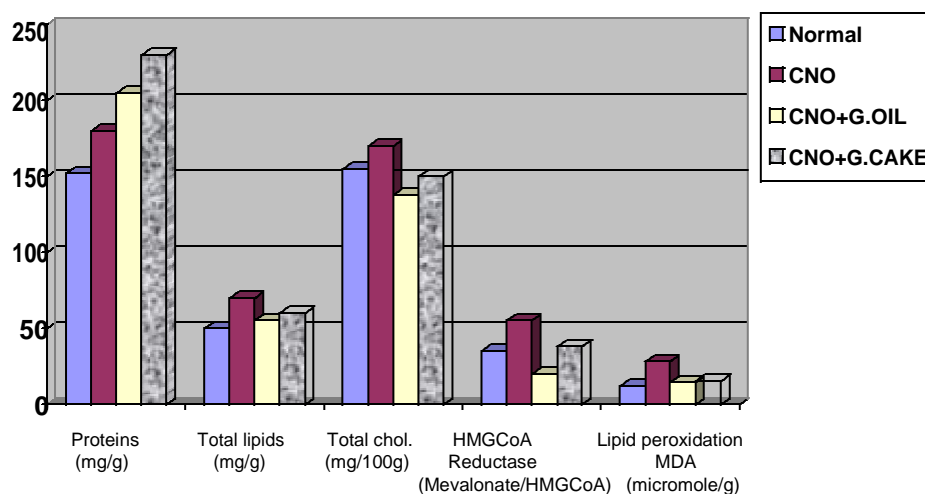*Corresponding author. E-mail: ktaugusti@yahoo.co.uk.

Figure 1. Effects of garlic oil/cake on coconut oil fed rats (values are mean of six rats) liver parameters. p < 0.01 – 0.001 as compared to each control.

This work was related to the projects of M.Sc biochemistry students of this institution.

MATERIALS AND METHOD

Adult male albino rats 9 - 12 months old and weighing 200 – 250 g was selected from our animal colony. They were divided into four groups containing six rats in each group and they were maintained on the stock laboratory diet (Gold Mohr rat feed, Supplier Brook Bond Lipton India Ltd, Bangalore). Each rat consumed about 15 g rat feed/day.

Garlic oil was the essence prepared from a homogenate of fresh garlic, dried under sun (garlic powder) by repeated extraction of it with diethyl ether in a soxhlet apparatus for 12 h in a span of three days. The oil left behind after removal of ether at 40 - 45°C was used in this study (Yield 8 g /Kg). The oil free cake of garlic obtained after a 2nd sun drying was also used to feed the rats. Locally purchased coconut oil was used in the present study and it was orally administered to the test groups with a stomach tube. Group I - Normal control was maintained on normal rat feed (Average consumption 15 g/day); Group II – 3 ml coconut oil+12 g rat feed/rat (to compensate calorie consumption); Group III - Garlic oil (10 mg/100 g body wt/day) was dissolved in 3 ml coconut oil +12 g rat feed / rat; Group IV – 3 ml coconut oil + 1 g garlic cake +11 g rat feed/rat.

After one month feeding of the above items the weights of the rats were noted and they were sacrificed by decapitation after over night fasting. Blood, liver, heart, kidney and aorta were collected for various estimations of the biochemical parameters.

Blood glucose was estimated using glucose oxidase (Trinder, 1969). Aspartate amino transferase (AST) and Alanine amino transferase (ALT) (Bergmeyer and Bernet, 1980) and Alkaline phosphatase (ALP) (Varley, 1975) in serum, thiobarbituric acid reactive substances (TBARS) (Niehans and Samuelson, 1968), HMGCoA reductase (Sheela and Augusti, 1995), total protein (Tietz, 1974) total lipids (Choudhary, 1989), cholesterol (Allain et al., 1974) and triacyl glycerol (Van Handel and Zilversmit, 1963) (TAG) were estimated in various tissue homogenates by standard methods. Data were analysed by student's t-test.

RESULTS AND DISCUSSION

In coconut oil fed rats, blood glucose, AST, ALT and ALP levels increased significantly by 17, 10, 11 and 50% respectively as compared to normal control (P < 0.01 - 0.001). On feeding garlic oil or garlic cake, the deleterious effects of coconut oil were reversed significantly (p < 0.01 - 0.001) i.e. blood glucose by 10% with garlic oil only and the enzymes AST by 9 &18%, ALT by 14 & 18% and ALP by 8 and 17% on feeding garlic cake and oil respectively. Therefore garlic oil showed far better effect than garlic cake. Serum proteins were not affected much by the feeding experiments. These results are given in Table 1. The variations of different biochemical parameters of heart and aorta are given in Table 2 and that of liver and kidney are given in Figures 1 and 2.

On administration of coconut oil to group 2 the total lipids, TAG, HMGCoA reductase and lipid peroxidation (TBARS values) in heart and aorta increased significantly (p < 0.02 - 0.001). In whole heart tissue cholesterol increase was non significant. On the contrary AST and ALT levels decreased and ALP level increased signifi-cantly in this group. On administration of garlic oil or gar-lic cake along with CNO total lipids significantly decree-ased in heart by 66 and 45% respectively (p < 0.01 - 0.001). A similar effect on total lipids was observed in aorta also. Similarly total cholesterol and TAG levels were also decreased significantly by garlic oil and cake and the percentage falls are depicted in the table. Similar ameliorative effects of garlic oil or cake were also observed on the levels of TBARS and the various enzymes studied in these tissues, that is, Lipid peroxidation was decreased, HMGCoA reductase, AST, ALT and ALP levels were brought up or down, towards normal. With respect to the parameters in liver and kidney on admini-
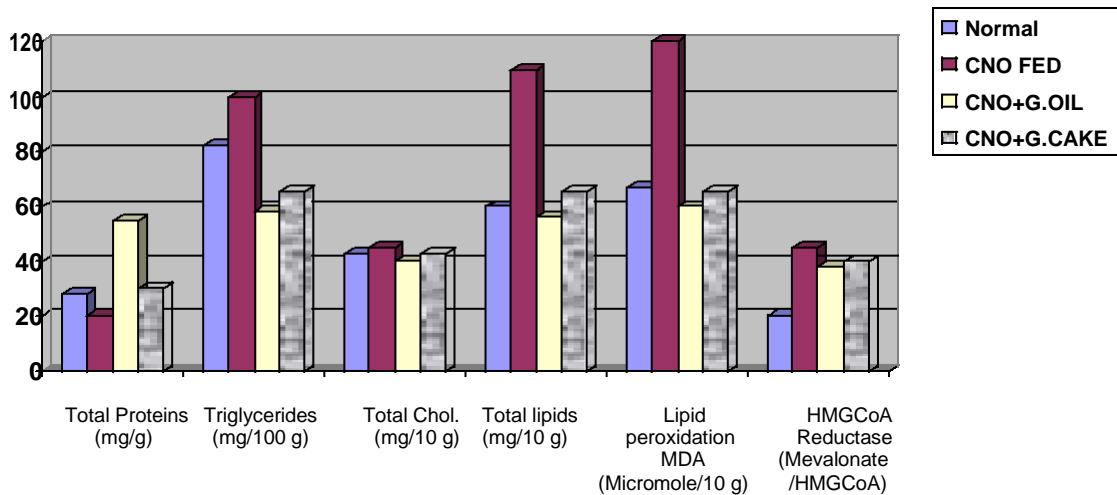
Figure 2. Effects of garlic oil/cake on coconut oil fed rats (values are mean of six rats). Kidney parameters p < 0.01 – 0.001 as compared to each control. Triglyceride on CNO fed groups is not significant.

Table 1. Effects of garlic oil/cake on the blood/serum parameters of rats fed with coconut oil (CNO) values are mean ± s.d. of six rats. Percentage fall or rises are given in the parenthesis.

Parameters	Normal	Coconut oil	CNO+ G.oil	CNO + G Cake
Blood glucose (mg/dl)	90 ± 5	105 ± 6 (17%)	95 ± 5 (-10%)	100 ± 6 (-5%) N.S
AST (IU)	50 ± 1.7	55 ± 2.4(10%)	45 ± 2.6(-18.2%)	50 ± 2.2(-9%)
ALT (IU)	42 ± 1.5	46.6 ± 1.2 (11%)	38 ± 1.4(-18%)	40 ± 1.7(-14%)
ALP (KA)	80 ± 7.5	120 ± 8.3(50%)	100 ± 7.6(-17%)	110 ± 8(-8%)

Student's t – test P < 0.05 - 0.001 as compared to control of each. N.S = Not significant.

Table 2. Effects of treatment as in Table 1 on heart and aorta of the rats values are mean ± s.d. of six rats. Percentage fall or rises are given in the parenthesis.

Parameters	Normal	Coconut oil	CNO + G. oil	CNO +G. cake
Heart tissue (mg/g) Total lipids	0.113 ± 0.01	0.38 ± 0.08 (236%)	0.13±0.03 (-66%)	0.21 ± 0.07(-45%)
Total cholesterol	1.06 ± 0.22	1.2 ± 0.15(13%) N.S	0.6 ± 0.11 (-50%)	0.7 ± 0.2(-41%)
TAG	8.7 ± 0.50	9.65 ± 0.54(11%)	7.7 ± 0.06 (-20%)	8.6 ± 0.39(-11%)
Lipid peroxidation TBARS (μ mole MDA)	12.56 ± 0.35	50.26 ± 0.40 (300%)	12.56 ± 0.36 (-75%)	12.54 ± 0.36 (-75%)
HMGCoA Reductase (Mevalonate/HMGCoA)	0.36 ± 0.04	0.83 ± 0.05 (130 %)	0.35 ± 0.01 (-58%)	0.37±0.05 (-55%)
AST (IU)	0.447 ± 0.06	0.341 ± 0.04 (-24%)	0.435 ± 0.05 (27%)	0.37 ± 0.02(9%) N.S.
ALT (IU)	0.535 ± 0.04	0.45 ± 0.04(-16%) NS	0.50 ± 0.023 (11%)	0.4± 0.01(-11%) NS
ALP (KA)	6 ± 0.34	16.5 ± 0.35 (176 %)	4.72 ± 0.4 (-71%)	5 ± 0.15(-69%)
Aorta Tissue (mg/g) Total Chol	2 ± 0.14	3 ± 0.31 (50%)	1.5 ± 0.14 (-50%)	1.4± 0.14(-53%)
TAG	7±0.6	12 ± 0.34 (71%)	8 ± 0.52 (-33%)	8.2 ± 0.38(-31%)
Total lipids	21.7 ± 0.48	23.1 ± 0.38 (6.5%)	17 ± 0.31 (-26%)	21.5 ± 0.42(-7%)

Student's t- test P < 0.05 - 0.001 as compared to each control NS = Not significant
In parenthesis – Sign indicates percentage fall and other values a rise from the normal value or test control.

administration of coconut oil to group 2, total lipids, HMGCoA reductase and TBARS increased significantly both in liver and kidney as compared to normal. However protein level increased in the liver but decreased in the kidney significantly (p < 0.02 - 0.001). On feeding garlic oil or cake most of these parameters were significantly altered towards normal, except the protein level in liver where it was only increased by the drugs. From the results garlic oil is far more active than the cake.

However we must also note that garlic cake is also a source of active ingredients left after the formation of oil from S-allyl cysteine sulfoxide (SACS) by the action of allinase. Some undecomposed SACS, its reduced form S-allylcysteine (SAC), SACS in combination with sulfur containing peptides etc are also antioxidants. SACS and its derivatives are endowed with very many biological actions including anticancer and related actions as claimed by many (garlic @ mistral.co.uk). Therefore oil free garlic cake is also useful. Other advantages of garlic as well as onion principles are their inhibitory effects on platelet aggregation via blockage of thromboxane and prostaglandin synthesis (Vanderhoek, 1980) and enhancement of blood fibrinolysis (Bordia et al., 1977; Augusti et al., 1975) and immunity (Girija et al., 2006).

The observations of the present study indicate that coconut oil at 20% energy level of the diet is harmful and that the garlic principles could ameliorate the deleterious effects of coconut oil. The bad effects of coconut oil may be due to its high saturation. Traditionally Keralites used whole coconut kernel largely in their food items and the use of coconut oil was minimum. Kernal contains good fiber and this gives protection from the hyperlipidemic effects of its oil (Whitaker, 1976). Therefore the incidence of atherogenesis or heart diseases was minimal in Kerala. Now the situation has changed that the use of kernel is minimized and the use of oil is increased. Readers may understand this situation and then only find fault with the oil. There is no cholesterol in the vegetable oils, but excessive use may convert them into cholesterol in the body. This conversion and deposition of cholesterol and lipids in blood vessels and tissues and the conesquent lipid peroxidation could be prevented by garlic sulphur compounds. They consume to a great extent NADPH and free radicals that are required for lipid synthesis and lipid peroxidation respectively. These lipogenic/peroxidation processes are harmful to all organs, particularly the heart. The chemical reactions of garlic principles may be represented as follows:-
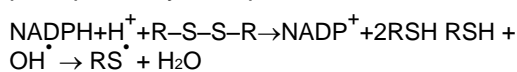
$NADPH + H^+ + R-S-S-R \rightarrow NADP^+ + 2RSH \; RSH +$
$OH^\bullet \rightarrow RS^\bullet + H_2O$
$2RS^\bullet \rightarrow R\text{-}S\text{-}S\text{-}R$ Free radical removal is an antioxidant action.

Dot indicates free radicals. In addition to the above the garlic polysulfides in the oil can react with thiol groups of enzymes and other macromolecules and pathogens in the body and regulate their actions so as to benefit the

host if the oil is not in excess (Wills, 1956) to over react with all thiols in the system.

$R_1 SH + RSSR \quad R_1SSR + RSH$

Garlic and onions contain similar sulfur compounds which are good antioxidant and hypolipidemic agents (Lin, 1989; Adoga and Osuji, 1986; Sodimu et al., 1984; Nagai and Osawa, 1974; Sogani and Katoch, 1981; Augusti and Sheela, 1996; Kandil et al., 1987; garlic @ mistral.co.uk) as indicated by the above equations. Garlic oil is superior to onion oil (Vanderhoek et al., 1980; Bordia et al., 1977; Augusti et al., 1975; Girija et al., 2006) as the former contains a more active allyl group while the latter contains only a less active propenyl group. However it is better to use both of them as functional foods as is the practice for many nations. Those who dislike garlic or its oil can use at least garlic cake.

DEDICATION

This paper is dedicated to the cherished memories of two late venerable teachers Dr H. D. Brahmachari and Dr. V. K. Sukumaran Nair. The former was the senior author's PhD guide (1959 - 1964) and the latter was his mentor (1972 - 1985) and a former Vice Chancellor of Kerala University respectively.

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