Certain medicinal effects of onion and garlic and their volatile unsaturated principles have been observed be-
due to their sulfur compounds. Gas-

Hypolipidemic action of onion and garlic unsaturated oils in sucrose fed rats over a two-month period

I. Adamu, P.K. Joseph and K.T. Augusti

Department of Biochemistry, College of Medical Sciences, University of Maiduguri, Maiduguri (Nigeria), 22 September 1981

Summary. The feeding of a high-sucrose diet to normal rats for a period of 2 months increased serum and tissue cholesterol and triglycerides very significantly. Simultaneous feeding of the unsaturated oils of onion or garlic with the sucrose diet counteracted these effects of sucrose. However, along with the lipid-reducing effects, a small but significant tissue-protein reducing effect of the oils was also observed. The hypolipidemic action of the oils may be related to their action on both lipid and protein synthesis.

Materials and methods. Allyl propyl disulphide and diallyl disulphide were prepared according to a published modification17 of the method of Plateau14 from fresh onion and garlic respectively. Male Wistar rats (average weight 150 g) were used for the experiments. They were divided into 4 groups of 6 each. 1 group was maintained ad libitum on a rat diet supplied by Pfizer (Kaduna, Nigeria). The composition of the diet was carbohydrate 73%, protein 16%, fat 3%, fiber 5%, minerals 2% and vitamin supplements 1%. This group was kept as a control group. The other 3 groups i.e. groups 2, 3 and 4 were given a sucrose-rich diet19 ad libitum. This diet was composed of 73% sucrose, 20% milk powder, 5% fiber (Millet husk) and 2% salt mixture enriched with vitamins. The 2nd group of rats were kept as a sucrose control group. The 3rd group of rats were given the unsaturated onion oil (100 mg/kg/day) and the 4th group was given the unsaturated garlic oil, in the same dose as above, as a saline suspension through stomach tubes. Feeding of the sucrose rich diet and the 2 unsaturated oils was continued for a period of 2 months. At the end of the 60th day the rats were sacrificed and their blood, livers, and kidneys were collected for various estimations. Blood sugar was estimated by the method of Asatoor and King20. Serum albumin and total protein were determined by the method
of Reinhold, liver and kidney proteins were determined by the method of Lowry et al., serum, liver and kidney triglyceride glycerol by the method of Burton, serum, liver and kidney cholesterol by the method of Zlatkis et al. Liver total lipids by the method of Koch-Weser et al.

Statistical analysis of the results were made according to Student's t-test.

**Results.** The results are given in the table. The values obtained from the sucrose-fed group are compared with those of the normal group, and the values for the groups fed sucrose plus onion oil or garlic oil are compared with those of the sucrose-fed group.

**Effects on blood sugar.** In the sucrose-fed group or in the sucrose plus oil-fed groups there was no significant change in the blood sugar.

**Effects on lipid levels.** Sucrose feeding increased the total cholesterol levels in serum, liver and kidneys significantly (p < 0.01). The increase was 31% in serum, 46% in liver and 35% in kidneys. Feeding of onion or garlic unsaturated oils along with sucrose counteracted the cholesterol-increasing effect of sucrose effectively, and the levels of cholesterol were maintained at nearly normal levels in serum, liver and kidneys. The cholesterol-reducing effects of the oils are highly significant (p < 0.001). Sucrose feeding raised triglyceride levels in serum, liver and kidney significantly (p < 0.001). The increase was to about 2.5 times the normal values in serum, liver and kidneys. Both onion and garlic unsaturated oils counteracted the triglyceride raising effect of sucrose effectively, and maintained the triglyceride levels within the normal range in liver and kidneys and at about 50% of the sucrose-fed values in serum. The triglyceride lowering effects of the oils are highly significant (p < 0.001). Sucrose feeding also increased the liver total lipids. The increase was 48% and is significant (p < 0.002). Onion and garlic unsaturated oils counteracted this effect of sucrose and maintained the total lipids within the normal range. The lipid-reducing effects of the oils are highly significant (p < 0.01 for onion oil and p < 0.001 for garlic oil).

**Effects on protein levels.** Neither sucrose nor sucrose plus the unsaturated oils had any effect on serum total proteins or on the albumin to globulin ratio. Similarly, sucrose feeding showed no significant change in liver total proteins. However, sucrose plus the oils decreased the liver total proteins to subnormal levels; the decrease was 22% for the onion oil and 24% for the garlic oil group. With onion oil the decrease was just significant (p < 0.05), but with garlic oil the decrease was highly significant (p < 0.01). Neither sucrose nor sucrose plus onion oil had any effect on kidney total proteins. However, sucrose plus garlic oil had a significant protein-reducing effect on the kidneys (p < 0.02).

In short, sucrose feeding increases the serum and tissue lipids, and the unsaturated oils of onion and garlic counteracted this effect. In addition, these oils also have a protein-reducing effect, which is pronounced for liver proteins.

**Discussion.** The observed lipid-reducing-action of the oils indicates the potential medicinal value of onion and garlic. The organic disulphides found in the 2 oils are good acceptors of hydrogen and their biological actions may be ascribed partly to their reactions with thiol group substances and partly to that with reduced pyridine nucleotides, eg. NADPH. It is established that organic disulphides can inactivate thiol group (-SH) substances as a result of thiol-disulphide exchange reactions and that they can easily oxidize NADPH.

The reaction mechanisms are possibly as follows:

\[ \text{O-SH} + \text{R-SH} + 2 \text{NADPH} + 2 \text{H}^+ \rightarrow \text{O-S-S-R} + \text{R-SH} + 2 \text{NADP}^+ \]

\[ \text{C}_3\text{H}_5\text{S-S-R} + 2 \text{NADPH} + 2 \text{H}^+ \rightarrow \text{C}_3\text{H}_5\text{SH} + \text{R-SH} + 2 \text{NADP}^+ \]

Where R is \( \text{C}_3\text{H}_5 \) or \( \text{C}_3\text{H}_7 \) and O-SH stands for any thiol group compound. As such reactions could inactivate thiol group enzymes, eg. CoA and HMG CoA reductase, and also oxidize NADPH, and all these are necessary for lipid synthesis, the daily intake of onion or garlic or their oils may reduce lipid synthesis in the body.

The aminoacid cysteine is inactivated by organic disulphides and such reactions of the disulphides present in the above oils may partly inhibit protein synthesis also. However, this effect of the oils is not much pronounced, and if they are used only in small quantities, they may not affect the general health, but only control lipid accumulation. A definite conclusion regarding the mechanism of action of the 2 oils in sucrose-fed rats can be drawn only after the determination of individual enzymes, proteins and NADPH in the test animals.

This and previous experiments show that either the extracts or the oils of onion and garlic could counteract the lipid-increasing effect of sucrose very effectively. As sucrose and the above vegetables are important ingredients of our food, and also as the adverse effects of the former are counteracted by the disulphides of the latter, the present results serve as a guide line for adjusting the use of onion and garlic.